A NEW

UNIVERSAL HISTORY

OF

ARTS and SCIENCES,

SHEWING THEIR

ORIGIN, PROGRESS, THEORY, USE and PRACTICE;

AND EXHIBITING

The *Invention*, *Structure*, *Improvement*, and *Uses*,

Of the most considerable

INSTRUMENTS, ENGINES, and MACHINES,

WITH

Their *Nature*, *Power*, and *Operation*,

DECYPHERED IN

FIFTY TWO COPPER-PLATES.

VOL. II.

LONDON:
Printed for J. Coote, at the King's Arms, in Pater-Noster-Row.
MDCCLIX.

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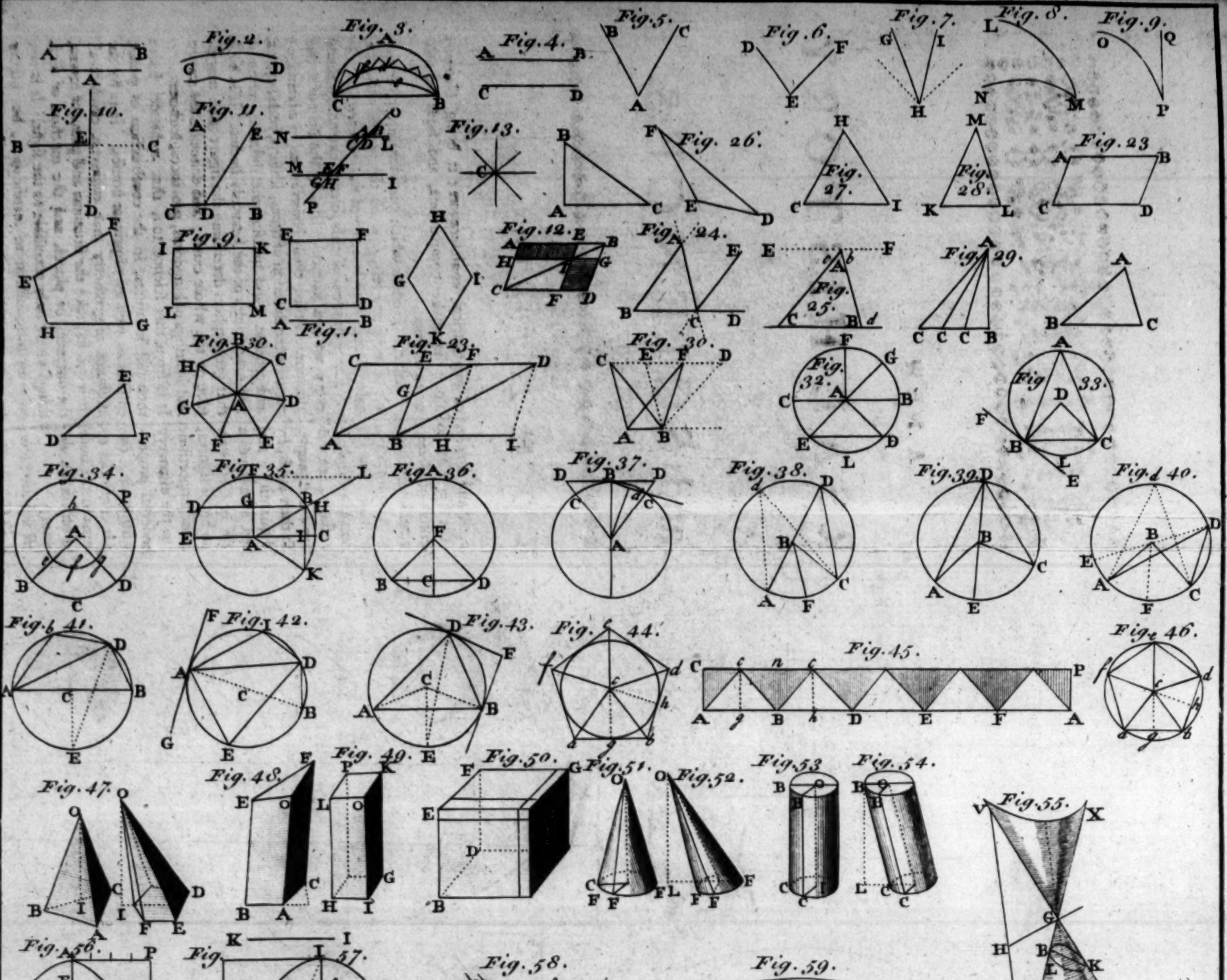
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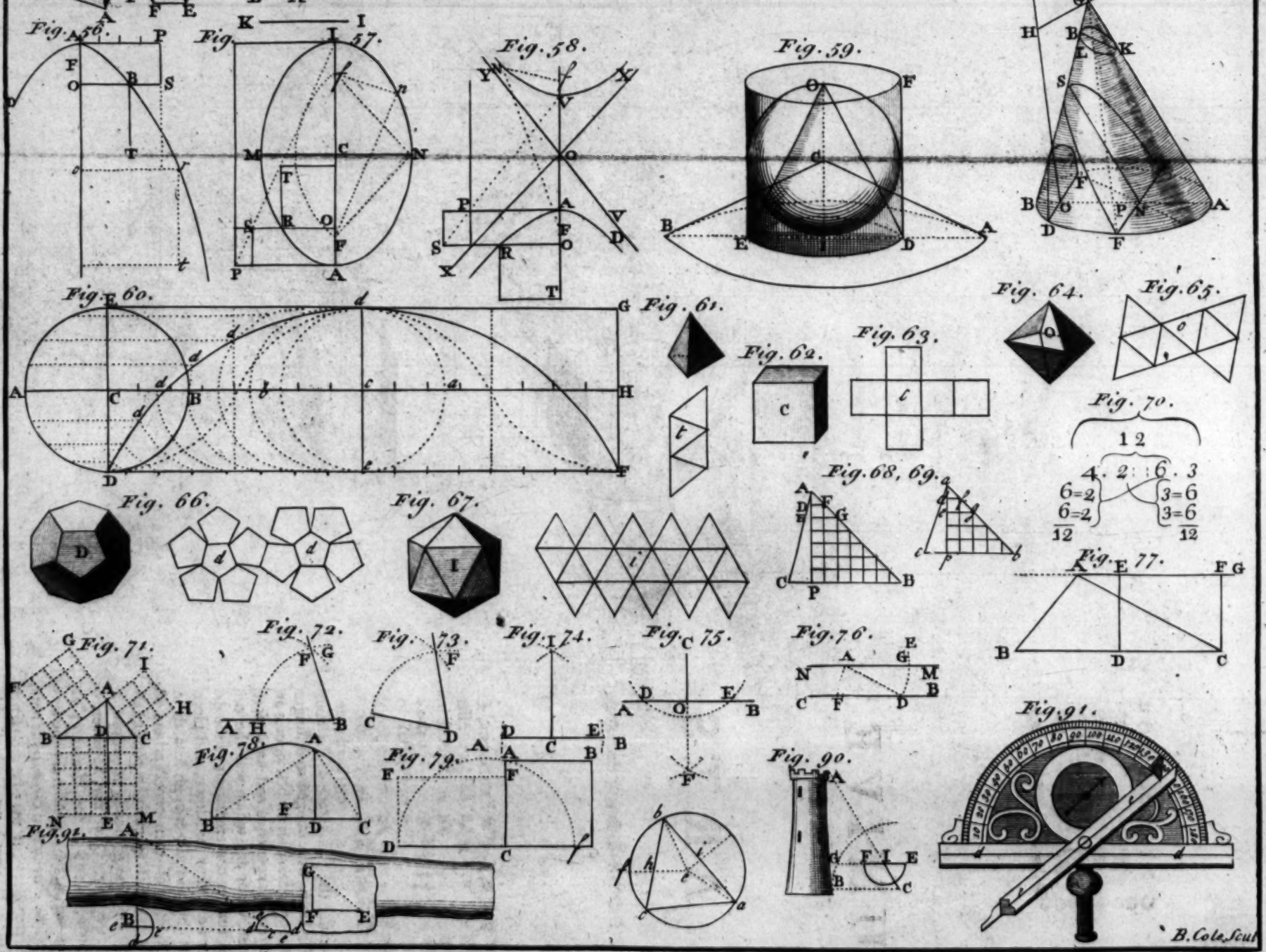
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GEOMETRY.

HERODOTUS, *Lib.* 2. and *Strabo*, *Lib.* 17. assert the *Egyptians* to be the first inventors of *Geometry*; and the annual inundations of the *Nile* to have been the occasion; for that river bearing away all the bounds and landmarks of men's estates, and covering the whole face of the country; the people, say they, were obliged to distinguish their lands, by the consideration of their figures and quantity; and thus by experience and habit formed themselves a method or art, which was the origin of *Geometry*. A further contemplation of the draughts of figures, or fields thus laid down, and plotted in proportion, might naturally enough lead them to the discovery of some of their excellent and wonderful properties; which speculation continually improving, the art became gradually improved, as it continues to do this day. *Josephus*, however, seems to attribute the invention to the *Hebrews*; and others among the antients make *Mercury* the inventor.

The province of *Geometry* is almost infinite: few of our ideas but may be represented to our imagination by lines; upon which they strait become of geometrical consideration; it being *Geometry* alone that makes comparisons, and finds the relations of lines.

All the sciences which consider things susceptible of more and less, *i. e.* all the precise and accurate sciences may be referred to *Geometry*.

The usefulness of this science extends to almost every art and science. It is by the help of it that astronomers turn their observations to advantage; regulate the duration of times, seasons, years, cycles, and epochas; and measure the distance, motions, and magnitudes of the heavenly bodies. It is by it that geographers determine the figure and magnitude of the whole earth; and delineate the extent and bearings of kingdoms, provinces, harbours, &c. It is from this science too, that architects derive their just measures, in the construction of public edifices as well as of private houses. It is by the assistance of geometry that engineers conduct all their works, take the situation and plans of towns, the distances of places, and the measure of such things as are only accessible to the sight. It is not only an introduction to fortification, but highly necessary to most mechanics, especially carpenters, joiners,

joiners, mathematical-instrument-makers, and all who profess designing.

On geometry likewise depends the theory of music, optics, perspective, drawing, mechanics, hydraulics, pneumatics, *&c.*

GEOMETRY, of γη, earth, and μετρεω, to measure, is the science or doctrine of extension, or extended things; that is, of *lines*, *surfaces*, and *solids*, and it is divided in four parts, *viz.* *planimetry*, *altimetry*, *longimetry*, and *stereometry*.

Planimetry is that part of *geography*, which considers lines, and plain figures, without any consideration of heights or depths; but it is more particularly restrain'd to the mensuration of planes, or surfaces.

This art, of measuring the surfaces or planes of things, is performed with the squares of long measures, as square inches, square feet, square yards, square perches, *&c.* that is, by squares whose sides are an inch, a foot, a yard, a perch, *&c.* So that the area, or center of any surface is said to be found, when we know how many such square inches, feet, yards, *&c.* it contains.

Altimetry is the art of taking or measuring altitudes or heights, whether accessible or inaccessible. This art makes the first part of *geometry*.

Longimetry is the art of measuring lengths; both accessible, as roads, *&c.* and inaccessible, as arms of the sea.

Stereometry teaches how to measure solid bodies, *i. e.* to find the solidity, or solid contents of bodies; as globes, cylinders, cubes, vessels, ships, *&c.*

GEOMETRY, again, is distinguished into *speculative* and *practical*.

The first contemplates the properties of continuity; demonstrates the truth of general propositions, called *theorems*.

The second applies those speculations and theorems, to particular uses in the solution of *problems*.

Speculative Geometry, again, may be divided into *elementary* and *sublime*.

Elementary or *common geometry* is that employ'd in the consideration of right lines, and plain surfaces, and solids generated therefrom.

Higher or *sublime geometry* is that employed in the consideration of curve lines, conick sections, and bodies form'd thereof.

But previous to either part, we must observe that there are three sorts of principals from which all *geometrical* propositions are deduced; *viz.* the *definition*, *postulate*, and *axiom*.

We call *definition*, the explication of the name, or of the thing; as when somebody says that he understands by the name of *triangle*, *a figure composed of three lines*.

A *postulate* is a clear, evident proposition wherein it is affirmed or denied, that something may or may not be done.

An *axiom* is a self evident truth, or a proposition, whose truth every person perceives at first sight: Thus, that the whole is greater than its part, is an *axiom*.

Then of *propositions*, some propose something to be done, and are *problems*; as to divide a line, to make an angle, to draw a circle thro' three points not in a right line: others consider the properties of things already made, or done; and are called *theorems*. Thus if a triangle be compar'd with a parallelogram, standing on the same base, and of the same altitude, and partly from their immediate definitions, and partly from other of their properties already determin'd, it is inferred that the parallelogram is double the triangle, that proposition is a *theorem*.

Two things are to be chiefly regarded in every *theorem*, *viz.* the proposition, and the demonstration: In the first is expressed what agrees to some certain things under certain conditions, and what does not. In the latter, the reasons are laid down by which the understanding comes to conceive, that it does, or does not agree thereto.

There are various kinds of *theorems*; as, *universal*, *particular*, *negative*, *local*, *plane*, *solid*, *reciprocal*.

Universal Theorem, is that, which extends to any Quantity, without restriction, universally; as this, *that the rectangle of the sum, and difference of any two quantities is equal to the difference of their squares*.

Particular Theorem is that, which extends only to a particular quantity; as this, *in an equilateral right lined triangle, each of the angles is 60 degrees*.

Negative Theorem is that, which expresses the impossibility of an assertion; as, *that the sum of two biquadrate numbers cannot make a square number*.

Local Theorem is that, which relates to a surface; as, *that triangles of the same base and altitude are equal*.

Plane Theorem, is that which either relates to a rectilinear surface, or to one terminated by the circumference of a circle; as, *that all angles in the same segment of a circle are equal*.

Solid Theorem is that, which considers a space terminated by a solid line; that is, by any of the three conick sections, *e. gr.* this, *that if a right line cut two asymptick parabola's, its two parts terminated by them shall be equal*.

Reciprocal Theorem is one, whose converse is true; as, *that if a triangle has two equal sides, it must have two equal angles*: The converse of which

which is likewiſe true, that if it has two equal angles, it muſt have two equal ſides.

Others are only laid down in order to clear the way for ſome following demonſtration; and prefixed either to theorems, in order to render their demonſtration leſs perplexed and intricate; or to problems, to make their reſolution more eaſy and ſhort; and theſe are called *lemmas*. Thus to prove a pyramid one third of a priſm, or parallelepid, of the ſame baſe and height with it; the demonſtration whereof in the ordinary way is difficult and troubleſome; this *lemma* may be premiſed, which is proved in the rules of progreſſion, *that the ſum of the ſeries of the ſquares, in numbers in arithmetical progreſſion, beginning from* 0, *and going on* 1, 4, 9, 16, 25, 36, &c. is always ſubtriple of the ſum of as many terms equal to the greateſt; or is always one third of the greateſt term multiplied by the number of terms. Thus to find the inflection of a curve line, this *lemma* is firſt premiſed; *that the tangent may be drawn to the given curve, in a given point.*

Laſtly, others neceſſarily follow from others, and are called *corollaries*.

Scholium, is a note, annotation, or remark, occaſionally made on ſome propoſition whereby, it is better explained, or its uſe or utility made more apparent.

A *propoſition* is ſaid to be the converſe of another, when, after drawing a concluſion from ſomething firſt ſuppoſed, we proceed to ſuppoſe what had been firſt concluded, and to draw from it what had been ſuppoſed. Thus it is demonſtrated in *geometry*, that if the two ſides of a triangle be equal, the two angles oppoſite to thoſe ſides, are equal alſo: The converſe of the propoſition is, *that if the two angles of a triangle be equal, the two ſides oppoſite to thoſe angles are equal alſo.*

This mark + ſignifies *more*; — ſignifies *leſs*; = ſignifies *equality*.

From theſe general, and neceſſary obſervations, I'll paſs to the *ſpeculative* GEOMETRY, beginning by the *lines* and *angles*.

MAGNITUDE, is all that whereby a thing compared with another of the ſame kind, is ſaid to be equal, or unequal to it; therefore it comprehends local extenſion, number, motion and time.

Local extenſion, or quantity of bigneſs, is a certain and definite ſort of magnitude, *viz.* what is anſwered to a perſon who aſks, how big is ſuch a thing? and that quantity is either conſidered in length only, and is called *line*; or in length and breadth, and is called *ſuperficies*; or laſtly, in length, breadth, and depth, and is called *ſolid*.

A *point* in *geometry*, according to *Euclid*, is a quantity which has no parts; or neither length, breadth, nor thickneſs, an object the ſmalleſt and leaſt ſenſible, made by the prick of a pen, *&c.*

A *line* is a length without breadth, or a continuation of points. There are as many ſorts of lines, as the point is ſuſceptible of different movements; amongſt which the *right line* and *curve* are moſt in uſe.

A *right line* is that, which is drawn equally between its two extremities, whoſe points tend the ſame way, as A B. *Fig.* 1.

A *curve* is a line, whoſe ſeveral points tend ſeveral ways, as C D, *Fig.* 2.

If two or ſeveral lines are contained within the ſame terms, that which is right, is the ſhorteſt, as C B, *Fig.* 3. And the *curves* which contain the others, are bigger than thoſe they contain, as C *d* B is greater than C *e* B, which is only true when thoſe *curve lines* are incurvated in the ſame part; for if the line contained is bent in ſeveral parts, and forms ſeveral windings, it may be bigger than that which contains it, as C F B is greater than C A B.

If two lines are every where equidiſtant from each other; and though infinitely produced would never approach nearer, or recede farther from each other, they are called *parallel*, as A B, and C D, *Fig.* 4.

The *aperture*, or mutual inclination of two lines, which meet in one point of interſection, is called *angle*, as B A C, *Fig.* 5. and the point, in which the lines meet, is called the *vertex* of the angle, as A, therefore every angle is commonly expreſſed by three letters, that of the *vertex* being in the middle.

However the quantity of the angle is not taken from the length of the lines which form the angle, but from the arch deſcribed from its *vertex*, with any radius at pleaſure between its legs. For the angle D E F, *Fig.* 6. is greater than the angle G H I, *Fig.* 7. though formed of leſſer lines: For if the angle GHI be put on the angle DEF, marked with points, it will be eaſily underſtood, that the angle G H I is comprized in the angle D E F, and that the lines which form the angle D E F, are much more diſtant from each other, than thoſe which form the angle G H I.

Angles, made by lines in the ſuperficies, are call'd *ſuperficial*; and if that ſuperficies be plane, they are call'd *plane angles*; if ſpherical, *ſpherical angles*.

A *plane Angle*, if made of two right lines, is call'd *rectilinear*; ſuch are the angles of *Fig.* 5, 6, 7. if of *curve*, *curvilinear angle*; as L M N, *Fig.* 8.

Fig. 8. if of a right, and a curve, it is called *mixt*, as O P Q, *Fig.* 9.

Every *angle* is either *right*, *obtuſe*, or *acute*.

A *right angle*, is that formed by a line falling perpendicularly on another; or that which ſubtends an arch of 90 degrees; as the angle B E A, *Fig.* 10. The meaſure of a right angle, therefore, is a quadrant of a circle; and conſequently all right angles are equal to each other.

Therefore, when the right line A E, *Fig.* 10. placed on the right B E C inclines on neither part, and then forms angles every where equal; thoſe two angles, A E B and A E C, are right; and the right line A E, placed on the other, is call'd *perpendicular*.

Angles which have one ſide common and are formed of the one and other part of that ſide, are call'd *contiguous angles*; as *Fig.* 10. A E B and B E D; but if B E be produced in C, as A E is produced in D, the angles B E A, and D E C, are call'd *oppoſite angles*.

An *obtuſe angle*, is that greater than a right *angle*, or whoſe meaſure exceeds 90°, as the angle E D C, *Fig.* 11.

An *accute angle*, is that which is leſs than a right *angle*, or than 90°; ſuch is, in the ſame figure, E D B. We muſt obſerve, that there are *obtuſe angles*, as well as acute ones, bigger than the others.

The *angles* of any right-lined figure made without it, by producing all the ſides ſeverally, are called *external angles*; and thoſe made by the ſides of any right-lined figure within, *internal*.

All the *external angles* of any figure, taken together, are equal to four *right angles*; and the external angle of a triangle, is equal to both the internal and oppoſite ones. The ſum of all the *internal angles* of any right-lined figure, is equal to twice as many *right angles* as the figure has ſides, excepting four. The *external angle* is demonſtrated to be equal to the internal oppoſite one; and the two internal oppoſite ones, are equal to two right ones.

Alternate angles are the *internal angles* made by a line cutting two parallels, and lying on the oppoſite ſides of the cutting line; the one below the firſt parallel, and the other above the ſecond.

Firſt Theorem. A right line reſting on another right line, makes again two right angles, or equal to two rights.

For if A D, *Fig.* 11. falls perpendicularly on the line C D B, the angles A D B, and A D C, will be right angles, by the definition 11 and 12; but if E D reſts obliquely on the ſame line C D B, A D muſt be conceived the perpendicular; ſince, then, the angles E D B acute, and E D C obtuſe, occupy the ſame ſpace as the two rights A D B; and A D C will be equal to them, by the axiom, where there is a mutual congruency, there is an equality.

Congruency is when things compoſed together agree in ſuch a manner, that the extremities of the one fall on the extremities of the other, and neither exceed, nor are exceeded. As if a pedal line, applied to another pedal line, the laſt points of one ſhould fall on the laſt points of the other, and both form a line.

Corollaries. It will be demonſtrated in the ſame manner, (if more than one right line fall on the ſame right line, at the ſame point) that the angles they form are, together, equal to two right ones.

Two right lines, cutting mutually one another, as A E D, and B E C, *Fig.* 10. form, in the point of interſection, four angles equal to four right ones.

All the angles formed round one point C. *Fig.* 13. are equal to four right ones; for they are four right ones cut into ſeveral parts.

Second Theorem. The *angles*, oppoſite at the vertex, are equal.

For the *angle* B, *Fig.* 12. is equal to the *angle* C; which the better to demonſtrate, both muſt be joined with the intermediate angle A; for the angle B, and the angle A, together, are equal to two right angles, by the firſt theorem. Likewiſe the angle C, and the angle A, are equal to two right angles, by the ſame firſt theorem. Therefore the angles C and A, taken together, are equal to the angles B and A, taken together, and conſequently the common angle A, being taken off, the angles B and C will remain equal, by this axiom; *that if you take equals off equals, thoſe that remain will be equals*, which was to be demonſtrated.

Third Theorem. If the right line O P cuts the two right parallels N L, and M I, it will make the internal angle equal to the external oppoſite on the ſame part.

For as the lines L N and M I, *Fig.* 12. are parallel, they incline equally to the line O P, towards the ſame parts by the ſixth definition, and the 9 axiom; therefore the angles B and F, or A and E, formed by the inclination of the lines L N, and I M, to the line O P, are equal.

Fourth Theorem. *Alternate angles* are equal between themſelves.

For the angle B, *Fig.* 12. is equal to the angle C, oppoſite to it at the vertex, by the ſecond theorem. But the ſame angle B is equal to the angle F, by the third theorem; therefore the angle C is equal to the alternate angle F, by the ſecond axiom.

Fifth Theorem. If a right line cuts two parallels,

rallels, it makes the internal angles equal to two rights at the same parts.

For the alternate angles C and F, *Fig.* 12. are equal between them, by the fourth theorem; but the angles C and D placed again are equal to two rights by the first theorem; therefore the angles D and F are equal to two rights, which was to be demonstrated.

SCHOLIUM. *Converse propositions* have place in the three preceding theorems; for if the two lines L N and I M, *Fig.* 12. with the third O P, render the external and internal angles B and F, opposed on the same part, equal; they'll incline equally to the line O P, whence they'll be parallel by the 9 axiom.

Likewise, from the alternate angles C and F being equal, it follows that the lines L N and I M are parallel; for as the angles B and C, opposite at the vertex, are equal, and C is equal to F; the external angle B will be equal to the internal angle F; therefore by the preceding demonstration, the lines L N and I M will be parallel.

Lastly. If the internal angles D and F be equal to two rights, the lines L N and I M will be parallel likewise. For the angles B and D repeated, are equal to two rights, by the first theorem. But the angles D and F are also put equal to two rights, therefore the external and internal angles B and F are equal between them, and consequently the lines L N and I M are parallel.

From *angles* I'll pass to *Triangles*, *Quadrilaterals*, *Pentagons*, *Hexagons*, and other *Polygons*.

A *figure* is a space included on all sides, and is either plain or solid.

Plain figures are those which consist of lines traced on some superficies: which lines, if right, the figure is called *rectilinear*; if curve, *curvilinear*; if part curve and part right, *mixt*.

Those lines whereby the figure is terminated, taken together, are called its *circumference* or *circuit*, or *perimeter*. Whence figures which have an equal ambit, are called of the same name *isoperimetral*.

Of all *curvilinear*, and *mixt figures*, Geometers consider in a more particular manner, the circle or paction of the circle.

Among the *rectilinears*, the most simple is the *triangle*; because consisting only of three lines, which form as many angles.

A *triangle* is divided either according to its angles, or to its sides. If according to its angles it has either one of those angles right, and it is called *rectangular*, as A B C, *Fig.* 14. or it has one of them *obtuse*, and it is called *amblygonous*, as D E F, *Fg.* 15. or it has them all *acute*, and it is called *oxygonous*, as G H I, or K L M, *Fig.* 16. and 17.

But if it be divided according to its sides, and has three sides unequal, it is called *scalanous*, as A B C, *Fig.* 14. if it has only two sides equal, it is called *isosceles* or *equicrural Triangle*, as K L M, *Fig.* 17. if it has all the sides equal, it is said to be *equilateral*, as G H I, *Fig.* 16.

If two sides of a *triangle* be taken, they may be called limbs or legs, and then the third side will be called the *base*: any side may be taken for the base, though in a *rectangular*, or *amblygonous triangle*, the greatest side, *viz.* that which is opposed to a right angle, or to an *obtuse*, is commonly called the *base*, or the *hypotheneuse*, where it is question of a rectangular triangle: but in an *isosceles triangle* the unequal side is the base.

The figure which follows next the triangle is the *Quadrilateral*, which consists of four right lines, and as many angles.

If the *quadrilateral* has its opposite sides parallel, and equal to each other, it is called *parallelogram*, as A B C D, *Fig.* 18. otherwise *trapezium*, as E F G H, *Fig.* 19.

If the *parallelogram* has four right angles, it is called simply *rectangular*, as I K L M, *Fig.* 20.

If all the sides of a *rectangular* be equal, it is called a *square*, as C D E F, *Fig.* 21. which some make a species of *parallelogram*, others not: but if there are but the opposite sides equal, it is said *longer on the other parts*.

If all the sides be equal, and the angles unequal, it is called a *rhombus*, or *lozenge*, as G H I K, *Fig.* 22.

If both the sides and angles be unequal, it is called a *rhomboides*; as A B C D, *Fig.* 23.

A *parallelogram* is marked with four letters, placed at the four angles, as A B C D, *Fig.* 23. and likewise for brevity sake diametrically opposite, as B C and the diameter, or diagonal line, is that carried from an angle of the *quadrilateral*, to that opposite to it, as B C.

If thro' the point I, taken in the diagonal B C, *Fig.* 24. the two right lines E F, G H, are drawn parallel to the sides; the whole *parallelogram* will be divided into four *parallelograms*; two of which, *viz.* E G, H F, are called *parallelograms*, towards the diameter, and the two others, A I, I D, complements.

If the figure has more than four angles, and more than four sides, it is called a *polygon*; if six sides, an *hexagon*; if seven, a *heptagon*.

In every *parallelogram* the sum of the squares of the two diagonals is equal to the sum of the squares of the four sides. This proposition M. *de Lagny* takes to be one of the most important of all *Geometry*; he even ranks it with the celebrated 47th of *Euclid*, and with that of the similitude of triangles;

and adds, that the whole firſt book of *Euclid* is only a particular caſe hereof. For if the *parallelogram* be rectangular, it follows that the two diagonals are equal; and of conſequence, the ſquare of a diagonal, or which comes to the ſame thing, the ſquare of the hypotheneuſe of a right angle, is equal to the ſquares of the ſides. If the *parallelogram* be not rectangular, and of conſequence the two diagonals be not equal, which is the moſt general caſe, the propoſition becomes of vaſt extent: It may ſerve, for inſtance, in the whole theory of compound motions, *&c.*

Firſt Theorem. In all triangles, the outward angle is equal to two oppoſite inward; and three angles are equal to two rights.

Let the triangle be A B C, *fig.* 24. whoſe ſide B C muſt be produced in D: I ſay, *firſt*, that the external angle A C D, is equal to the two oppoſite internals, A and B: *ſecondly*, that the three angles A and B, and A C B, are equal to two right angles.

Demonſtration of the firſt part. Let the line C E be conducted parallel to B A; and then the right line A C will fall on the parallels A B and C E; therefore the angle A, or B A C will be equal to the alternate A C E: Likewiſe, the right B C will fall on the parallels B A and C E; therefore the internal angle B is equal to the external E C D, and conſequently the two A, and B, are equal to the two A C E, and E C D, *i. e.* to the whole A C D.

Demonſtration of the ſecond part. The two angles A and B, are equal to the angle A C D. Therefore the common A C B being added, the three angles A, and B, and A C B, are equal to the two A C D, and A C B; but A C D, and A C B, being repeated, are equal to two rights: therefore the three A, and B, and A C B, are equal to two rights, according to this axiom, *that things equal to the ſame thing, are alſo equal between themſelves.*

Pythagoras is ſuppoſed the author of this important queſtion, which is the 32d of the firſt book of *Euclid*; as it is of a continual uſe in *Geometry*, it muſt be very well learned. But there is another manner of demonſtrating it, which will appear eaſier and is as follows.

Let the triangle be A B C, *fig.* 25. I ſay, 1. That the three angles A, C, and B, are equal to two right angles; but if the line E F be drawn parallel to the ſide C B, it is certain that the angles *c* and *b*, adjacent to the angle A, joined together with that angle A, are equal to two right angles; but the angle *c*, is equal to the angle C, and the angle C to the alternate angle B: therefore, likewiſe, the angles C and B, joined to the angle A, are equal to two rights, according to the axiom, *that if equals be added to equals, all will be equal.*

I ſay, 2. That the external angle *d*, is equal to the two internals A and C, oppoſite to it; for the external angle *d*, and the internal B, taken together, are equal to two rights: but the angles A and C, together with the angle B, are equal, likewiſe, to two right angles, by the preceding demonſtration; then the external angle *d*, is equal to the two oppoſite internal A and C.

Corollaries. Three angles, of any *triangle*, taken together, are equal to three angles taken together of any other *triangle*; for they are every where equal to two rights.

Every *triangle* muſt have two acute angles; for if it had but one, the two others would be either right, or obtuſe, which cannot be ſaid; ſince three angles of a triangle are together equivalent but to two rights.

As often as two angles in a triangle, or ſeparate, or together will be equal to two angles, or ſeperate, or together in another triangle, ſo often the third will be equal to the other third angle.

Second Theorem. In all triangles the greater triangle, is that oppoſed to the greater ſide, and *viciſſim.*

For the angle E, *fig.* 26. oppoſed to the greater ſide D F, is greater than the angle D, or the angle F; but as the magnitude of the angle is taken from the diſtention of the lines it conſiſts of; and the more thoſe lines are diſtended the greater is the ſide; it is evident that the angle E, oppoſite to the greater ſide, is greater than any of the two others, D or F.

Likewiſe, for the ſame reaſon the greater ſide is oppoſed to the greater angle.

Corollaries. In the equilateral triangle G H I, the three angles are equal between them, becauſe oppoſed to equal ſides. They are alſo all acutes, for they cannot be all right, or all obtuſe, by what we have already obſerved.

In the iſoſceles triangle K M L, *fig.* 28. the angles K and L, placed on the baſe K L are equal, becauſe oppoſed to equal ſides.

The perpendicular A B, *fig.* 29. is the ſhorteſt of all the lines, which can be drawn from the point A, to the right B C: for as the angle B is a right one, the angle A C B muſt be acute: therefore A B is leſs than any of the lines A C.

From a point to a right line there cannot be drawn but one perpendicular.

Third Theorem. If one ſide of two triangles be equal to one, and the other to the other; and the angles contained in thoſe ſides be likewiſe equal, the baſes and all the triangles will be alſo equalized.

For if we underſtand that the triangle D E F muſt be put over the triangle A B C, the angle E will be congruous with the angle A, equal to it,

and the ſides E D and E F will agree with the equal ſides A B, and A C; ſo that the three points D, E, F, will fall on the three points B A C, therefore the whole baſe D F will fall on the whole baſe B C, then there will be a *congruency* between the angles D and F, and F and C, and with all the triangles; and therefore all will be equal, by the axiom, *that all things which agree mutually are equal*, which was to be demonſtrated.

COROLLARIES. For the ſame reaſon, *viz.* from the *congruency of two triangles*, if they ſhould have all their ſides mutually equal, they will have, likewiſe, all the angles equal, which are oppoſite to equal ſides, and all will be equal.

Likewiſe if in a *triangle*, two angles taken ſeparately, were equal to two angles of another *triangle*, taken alſo ſeparately, and one ſide was equal to the other ſide, all the reſt would be equal; becauſe if a *triangle* be impoſed on another *triangle*, they'll agree mutually.

Fourth THEOREM. In all *triangles*, any two ſides are greater than the third: this propoſition is like the axiom of *Archimedes*.

For, as we have already obſerved, a right line is the ſhorteſt of all the lines drawn from one point to the other point: and as when one ſide of the triangle is conducted, in a direct line, from one point to the other, the two other ſides deviate from the ſtrait way; and two ſides of the *triangle* muſt be greater than the third.

Fifth THEOREM. The oppoſite ſides of *parallelograms* are equal, and likewiſe the angles, and the parts made by the diameter.

Becauſe A B, and C D, *Fig.* 23. are parallel; and the right line B C falls on them, which is the *diameter*, or diagonal line of the *parallelogram* A B C D, the alternate angles A B C, and B C D, will be equal. Likewiſe, becauſe A C and B D are parallel, and the right line B C falls on them; the alternate angles A C B, and C B D will be equal: therefore the whole angle A C D, is equal to the whole angle A B D.

In the ſame manner I'll ſhew the angles A and D, to be equal between them.

But becauſe the triangles A B C, and C D B, have a common ſide B C, and the angles adjacent to that ſide are equal, the ſide A C will be likewiſe equal to that B D, as A B to C D; and likewiſe thoſe triangles will be equal.

COROLLARIES. The complements A I, I D, *Fig.* 12. are alſo equal between themſelves; for the two great triangles C B A, and C B D, are equal to the preſent theorem: therefore, if from them are drawn the equal triangles C I H, and C I F, and I B G, the reſiduous ſpaces A I, I D, which are the complements of the parallelogram, will be equal.

Between the parallels A B, C D, *Fig.* 4. the lines A C and B D, equally inclined towards them, are equal. The ſame thing may be ſaid of the lines I L and K M, *Fig.* 9. placed between I K and L M, and perpendicular to them. For a parallelogram is formed on either way, whoſe oppoſite ſides are equal.

Sixth THEOREM. *Parallelograms* placed on the ſame baſe, and between the ſame parallels, are equal.

Let the *parallelograms* be A E and A D, *Fig.* 30. placed on the ſame baſe A B, and between the parallels A B and C D; I ſay that they are equal, for in the triangles A C F and B E D, the ſide A C is equal to the ſide B E. By the preceding theorem likewiſe the lines C E and F D, being equal to the ſame A B, by the ſame theorem; if to both be added the common part E F, the whole ſide C F will be equal to the ſide E D, in the aforeſaid triangles; but becauſe of the parallels A C and B E, the internal and external angles A C F, and B E D are equal; therefore the triangles A C F and B E D are equal; therefore if the common part G E F be taken off, both the parallelograms C B and A D, will be equal; which was to be demonſtrated.

COROLLARIES. The ſame demonſtration may be eaſiy applied to parallelograms placed on equal baſes, and between the ſame parallels.

Triangles likewiſe, placed on the ſame or equal baſes, and between the ſame parallels are equal: for the triangle A B C, *Fig.* 30. is half of the parallelogram A B C E, as the triangle A F B is half of the parallelogram A B F D; and thoſe parallelograms A E, A D, are equal by the preſent theorem; and therefore the triangles are alſo equal by this axiom, which are halves of the ſame thing, are equal between themſelves.

Seventh THEOREM. All polygons may be divided into ſo many triangles as it has ſides: for if within the heptagon B C D F G H, *Fig.* 30. the point A be taken, from which lines are conceived drawn to every angle A B, A C, A D, *&c.* it is manifeſt that there will be as many triangles, as there are angles in the polygon.

COROLLARIES. All the angles together of any regular rectilinear figure, adequate twice as many right angles, taking off four, as the figure has ſides.

Let right lines be drawn from the point A, within the ſame figure, to all its angles, which may cut it into ſo many triangles as it has ſides; and becauſe the angles of every triangle are equal to two rights, the angles of all together are twice equivalent to ſo many rights as there are ſides; but the angles placed round the point A, are equal to four rights: therefore if you take off from all the triangles, the angles round the point A, the remaining

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ing angles placed at the circumference of the figure, adequate twice ſo many right angles, taking off four, as the figure has ſides.

Therefore, if we want to know to how many right angles, the angles of a regular rectilinear figure are equivalent, we muſt take 4 off the product, the right angles will remain, which are adequated by the internal angles of the figure. Thus a *chiliagon*, or a figure of 1000 ſides, has 1996 angles equal to right angles.

From the *triangle* I'll paſs to the *circle*.

A Circle is a plain figure, comprehended under one ſingle line, which returns into itſelf, having a point in the middle, from which all the lines drawn to the circumference are equal.

This *circumference*, or *periphery*, is the line terminating the circle, which mathematicians divide into 360 parts, which parts are commonly call'd *degrees*: therefore, a ſemi-circumference is divided into 180 parts; and a quarter of a *circle* into 90: each *degree* is divided into 60 *minutes*, each minute into 60 *ſeconds*, each ſecond into 60 *thirds*, &c.

The *center* of the *circle*, is the point from which all lines are carried equal to the circumference, as the point A, *Fig.* 32.

The *diameter*, is a right line paſſing through the center of the circle, and terminated on each ſide by the circumference thereof: ſuch is the line B C in the ſame *Fig.*

The *radius* or *ſemidiameter*, is a right line drawn from the center to the circumference; as A F, and A E, in the ſame *Fig.*

The *ſemicircle*, is a figure comprehended between the diameter of the circle, and half its circumference, ſuch is B G F C in the ſame *Fig.*

The *chord*, is a right line, terminated at each extreme in the circumference of the circle, without paſſing through the center; dividing the circle into two equal parts, call'd *ſegments*; as the right line D E, in the ſame *Fig.*

The arch, is a part of the circumference of the circle, leſs than a half, or ſemicircle; as the right line D E, in the ſame *Fig.*

Each arch is the meaſure of an angle, comprehended in the center of the circle, by two *radii* drawn to the extremes of the *arch*. Thus the arch D L E is the meaſure of the angle D A E, in the ſame *Fig.* and as in the center of every circle there may be formed four right angles, which ſhould divide the whole circumference of 360 degrees into four arches of 90 degrees each; each right angle muſt be of 90 degrees, as B A F, or F A C in the ſame *Fig.* Therefore, as we have already obſerved, all the right angles are equal between themſelves, becauſe each conſiſting of 90 degrees; conſequently obtuſe angles contain more than 90 deg. as G A C in the ſame *Fig.* but the acute angles contain leſs than 90 degrees, and are not always equal between themſelves, as F A G, G A B, B A D, D A E, E A C, in the ſame *Fig.* beſides, as often ſeveral angles take up the ſame number of degrees of their circumference, they are as often equal between themſelves.

The Tangent, is a right line which touches the circle, that is, meets in ſuch a manner as that though infinitely produced, it would never cut the ſame, that is, never come within the circumference: ſuch is the line H C, *Fig.* 35. which touches the circle in the point C, and is call'd the *tangent* of the arch B C, or of the angle B A C, meaſured by that arch. Such is likewiſe the line L F, called the *tangent* of the arch B F, *Fig.* 43. or of the angle C A F, *Fig.* 42. and ſuch is the line E B F, *Fig.* 33.

Tangent of a *conic ſection*, as of a parabola, is a right-line which only touches or meets the curve in one point, and does not cut or enter within the curve.

Method of Tangents. A method of determining the quantity of the *Tangent* of any algebraick curve; the equation defining that curve being given.

This method is one of the great reſults of the *Calculus Differentialis*.

Its uſe is very great in *geometry*; becauſe in determining the *tangents* of curves, we determine at the ſame time the quadratures of the culvilinear ſpaces, on which account it well deſerves to be here particularly inſiſted on.

To find the Sub-tangent in an algebraick curve, let the ſemi-ordinate $p\,m$ be infinitely near, another, then will be the differential of the abſciſs, and letting fall the perpendicular $= p$; will be the differential of the ſemi-ordinate. Draw therefore the *tangent*, the infinitely little arch m will be a right-lined right-angled triangle, uſually called the *characteriſtick triangle of the curve*, in regard curve lines are diſtinguiſhed from each other hereby.

Now by reaſon of the parallelelism of the right lines P M and $p\,m$; the angle $M\,m\,R = T\,M\,P$, wherefore the triangle $M\,m\,R$ is ſimilar to the triangle T M P. Let therefore $M\,P = x$ P $M = y$, then will $P\,p = M\,R = dx$ and $R\,m = dy$ conſequently.

$$R\,m : MR :: PM : PT$$
$$dy : dx :: y : \frac{y\,dx}{dy}$$

If then from the given equation of any curve, you ſubſtitute the value of dx to $y\,dx : dy$, in the general expreſſion of the *ſub tangent*; the differential quantities will vaniſh, and the value of the *ſubtangent* will come in common quantities; whence the *tangent*

gent itſelf is eaſily determined.——This we ſhall illuſtrate in a few examples:

1. The equation defining the common parabola, is,

$$a x = y^2$$

Hence $a\,dx = {}^2 y\,dy$

$$dx = {}^2 y\,dy : a$$

$PT = y\,dx : dy = 2y^2\,dy : a\,dy = 2y^2 : a = 2ax : a = 2x$. That is, the ſub-tangent is double the abſciſs.

2. The equation defining a circle is

$$a x - x x = y y$$

$$a\,dx - 2x\,dx = 2y\,dy$$

$$dx = 2y\,dy : (a - 2x)$$

$PT = dx : y\,dy = 2y^2\,dy : (a - 2x)\,dy = 2y^2 : (a - 2x) = (2ax - 2xx) : (a - 2x) = (ax - xx) : (\frac{1}{2}a - x)$ that is PC : PB :: AP : PT.

Therefore $AT = (ax - xx) : (\frac{1}{2}a - x) - x = (ax - xx - \frac{1}{2}ax + xx) : (\frac{1}{2}a - x) = \frac{1}{2}ax : (\frac{1}{2}a - x)$ that is PC : PA :: CA : AT.

3. The equation defining an ellipſis, is;

$$a y^2 = a b x - b x^2$$

Hence $2a\,y\,dy = a\,b\,dx - 2\,b\,x\,dx$

$$2a\,y\,dy : (a\,b - {}^2 b\,x) = dx$$

$PT = dy\,x : dy = 2a\,y^2 : (a\,b - 2\,b\,x) = (2\,a\,b\,x - 2\,b\,x^2) : (a\,b - 2\,b\,x) = (2\,a\,x - 2\,a\,x^2) : (a - 2\,x)$ that is, as the diſtance of the ſemi-ordinate from the center, is to the half axis, ſo is the abſciſs to the portion of the *ſub tangent* intercepted between the vertex of the ellipſis and the *tangent*.

Laſtly, for all algebraick curves, the equation being,

$$a\,y^m + b\,x^n + c\,y^r\,x^s + d = 0$$

$$m\,a\,y^{m-1}\,dy + n\,b\,x^{n-1}\,dx + s\,c\,q^r - x^{s-1}$$

$$dx + r\,c\,y^{r-1}\,x^s\,dy = 0\; n\,b\,x^{n-1}\,dx + s\,c\,y^r\,x^{s-1}\,dx = -m\,a\,y^{m-1}\,dy - r\,c\,y^{r-1}\,x^s - dy\,dx = -m\,a\,y^{m-1}\,dy - r\,c\,y^{r-1}\,x^s\,dy\; n\,b\,x^{n-1} + s\,c\,y^r\,x^{s-1}.$$

$$PT = \frac{y\,dx}{dy} = \frac{m\,a\,y^{m-r}\,c\,y^r\,x^s}{n\,b\,x^n - 1 + s\,c\,y^r\,x^{s-1}}.$$

Suppoſe, *e. gr.* $y^2 - a\,x = 0$; then, by comparing with the general formula,

$$a\,y^m = y^2 \qquad b\,x^n = a\,x$$

$$a = 1 \;.\; m = 2 \qquad b = -a \;.\; n = 1$$

$$c\,y^r\,x^s = 0 \qquad f = 0$$

$$c = 0,\; r = 0.\; f = 0.$$

Theſe values being ſubſtituted in the moſt general formula of the *ſub tangent*, we have the *ſub tangent* of the parabola of the firſt kind, $(-2 \,.\, 1\,y^{2-1} - 0 \,.\, 0\,y^0\,x^0) : 1 - a \times 1 - 1 + 0.\; 0\,y^0\,x^0) = -2y^2 : = 2y^2 : a$.

Suppoſe $y^3 - x^3\,a\,x\,y = 0$ then will

$$a\,y^m = y^3 \quad b\,x^n = x^3$$

$$a = 1 \quad m = 3 \quad b = 1 \quad n = 3$$

$$c\,y^r\,x^s = -a\,x\,y \quad f = 0$$

$$c = -a \quad r = 1 \quad f = 1.$$

Theſe values being ſubſtituted in the general formula of the *ſub-tangent*, we have the *ſub tangent* of the curve, whoſe equation is given, $PT = (-3.\; 1\,y^{3-1} - 1.\; -a\,y\,x) : (3.\; -1\,x\,1 - 1 + 1.\; -a\,y\,x\,1 - 1) = (-3\,y\,3 + a\,y\,x) : (-3\,x^2 - a\,y) = (3\,y^3 - a\,x\,y) : (3\,x + a\,y)$ conſequently $AT = (3\,y^3 - a\,x\,y) : (3\,x^2 + a\,y)\;(-x = 3\,y^3 - a\,x\,y - 3\,x^3 - a\,x\,y) : (3\,x^2 + a\,y) = (3\,a\,x\,y - 2\,a\,x\,y) : 3\,x^2 + a\,y$. The value of $y^3 - x^3$, that is $a\,x\,y : (3\,x^2 + a\,y)$ being ſubſtituted from the equation to the curve.

In the *Philoſophical Tranſactions*, we have the following method of drawing *tangents*, to all *geometrical* curves, without any labour, or calculation, by M. *Sluſius*.

Suppoſe a curve, whoſe points are all referable to any right-line given, whether that right-line is the diameter or not; or whether there be more given right-lines than one, provided their powers do but come into the equation. In all his equations he puts v for the line DA, y for BA; and for EB, and the other given lines, he puts $b\,d$, &c. that is, always conſonants.

Then, ſuppoſing DC to be drawn touching the curve in D, and meeting with EB produced in C; he calls the ſought line CA, by the name of a.

To find which he gives this general method. 1. Reject out of the equation all members, which have not either v or y in them; then put all thoſe that have y on one ſide; and all thoſe which have v, on the other; with their ſigns + or —; and the latter for diſtinction and eaſe ſake, he calls the right, the former the left ſide. 2. On the right ſide, let there be prefixed to each member, the exponent of the power, which v hath there, or which is all one, let that exponent be multiplied into all the members. 3. Let the ſame be done

alſo

alſo on the left ſide, multiplying each member there by the power of the exponent of y, adding this moreover, that one y muſt in each part, be changed into a. This done, the equation thus reformed, will ſhew the method of drawing the required *tangent* to the point D: for that being given, as alſo y, v, and the other quantities expreſſed by conſonants, a cannot be unknown. Suppoſe an equation $by - yy = vv$, in which E B is called b; B A $= y$, D A $= v$, and let a, or A C be required, ſo as to find the point C, from whence C D being drawn, ſhall be a true *tangent* to that curve Q D in D. In this example, nothing is to be rejected out of the equation, becauſe y or v are in each member; it is alſo diſpoſed, as required by the rule 1; to each part therefore, there muſt be prefixed the exponent of the powers of y or v, as in rule 2; and on the left ſide, let y be changed into a, and then the equation will be in this form, $ba - 2ya = 2vv$, which equation reduced, gives eaſily the value of $a = \frac{2vv}{b-2y} =$ A C, and ſo the point C is found, from whence the *tangent* D C may be drawn.

To determine which way the *tangent* is to be drawn, whether towards B or E, he directs to conſider the numerator and denominator of the fraction. For, 1. If in both parts of the fraction, all the ſigns are affirmative; or if the affirmative ones are more in number, then the *tangent* is to run towards B. 2. If the affirmative quantities are greater than the negative in the numerator, but equal to them in the denominator, the right-line drawn thro' D, and touching the curve in that point, will be parallel to A B: for in this caſe, a is of an infinite length. 3. If in both parts of the fraction, the affirmative quantities are leſs than the negative, changing all the ſigns, the *tangent* muſt be drawn now alſo towards B: for this caſe, after the change, comes to the ſame as the firſt. 4. If the affirmative quantities are greater than the negative in the denominator, but in the numerator are leſs, or *vice verſa*, then changing the ſigns in that part of the fraction, where they are leſs, the *tangent* muſt be drawn a contrary way, that is, A C muſt be taken towards E. 5. But whenever the affirmative and negative quantities are equal in the numerator, let them be how they will in the denominator, a will vaniſh into nothing; and conſequently, the *tangent* is either A D itſelf, or E A, or a parallel thereto; as will eaſily be found by the data. This he gives plain examples of, in reference to the circle; thus: Let there be a ſemicircle, whoſe diameter is E B, in which there is given any point: from which the perpendicular D A is let fall to the diameter. Let D A $= v$, B A $= y$, B E $= b$; then the equation will be $by - yy = vv$, and drawing the *tangent* D C, we have A C, or $a = \frac{2vv}{b-2y}$ Now, if b be greater than $2y$, the *tangent* muſt be drawn towards B; if leſs, towards E; if it be equal to it, it will be parallel to E B, as was ſaid in the firſt, ſecond, and fourth rules.

Let there be another ſemicircle inverted; as N D D, the points of whoſe periphery are referred to the right-line B E, parallel and $=$ to the diameter. Let N B be called d; and all things elſe as before; then the equation will be $by - yy = dd + vv - 2dv$; which being managed according to his rules, you have $a = \frac{2vv - 2dv}{b-2y}$.

Now, ſince v is here ſuppoſed to be always leſs than d; if b be greater than $2y$, then the *tangent* muſt be drawn towards E, if equal, it will be parallel to BE; if leſs, changing all the ſigns, the *tangent* muſt be drawn towards B, as by rules, fourth, fifth, and third.

But there could be no *tangent* drawn, or at leaſt E B would be it, if N B had been taken equal to the diameter.

Let there be another ſemicircle, whoſe diameter N B, is perpendicular to E B, and to which its points are ſuppoſed to be referred. Let N B be called b, and all the things elſe as above; the equation will be $yy = bv - vv$, and $a = \frac{bv - 2vv}{2y}$. If now b be greater than $2v$, the *tangent* muſt be drawn towards B, if leſſer, towards E, if equal, D A will be the *tangent*, as by rules 1, 4, and 5 appears.

Inverſe method of Tangents, is a method of finding the equation, or the conſtruction, of any curve; from the *tangent*, or any other line, whoſe determination depends on the *tangent* given.

Its application we ſhall give in what follows.—The differential expreſſions of the *tangent*, *ſub-tangent*, *&c.* being delivered under the laſt article; if you make the given value equal to the differential expreſſion, and either ſum up the differential equation, or, if that cannot be, conſtruct it, the curve required, is had. For example:

1. *To find the curve line, whoſe* ſub-tangent $= 2yy : a$.

Since the *ſub-tangent* of an algebraic line is $= ydx : dy$ we have

$$\frac{ydx : dy = 2yy : a}{aydx = 2y^2 dy}$$
$$\frac{adx = 2ydy}{ax = y^2}.$$

The curve ſought therefore is a parabola.

2. *To*

2. *To find the curve, whoſe* ſub-tangent, *is a third proportional to* r—x *and* y.

Since $r-x : y = y : \frac{y\,dx}{dy}$

We have $r-x : y = dy : dx$

$$r\,dx - x\,dx = y\,dy$$

$$rx - \tfrac{1}{2}x^2 = \tfrac{1}{2}y^2$$

$$2rx - xx = y^2$$

The curve ſought therefore, is a circle.

3. *To find a line, wherein the* ſub-tangent *is equal to the ſemiordinate.*

Since $y\,dx : dy = y$

$$y\,dx = y\,dx$$

$$dx = dy$$

$$x = y$$

Hence it appears, that the line ſought, is a right-line, which reſpects the cathetus of an equicrural triangle, as an axis, or the hypothenuſe of an equicrural rectangled triangle. If x had been taken for the arch of a circle, the ſought line had been a cycloid.

The line *ſecant* of ſome arch is a right line drawn from the center, carried through the other extremity of the ſame arch, and terminated by the tangent: as the line A B H, *fig.* 45. C B is the *ſecant* of the arch, or of the angle C A B; as likewiſe, the line A B L is the *ſecant* of the arch B F, or of the angle B A F.

The *right ſine* of an arch is a right line drawn from one extremity of the arch, perpendicularly upon the radius drawn from the other extremity; or the *ſine* is half the chord, of twice the arch; as the line B I, is the *right ſine* of the arch B C, in the ſame *fig.* Hence the *ſine* of a right angle is the radius itſelf, it being half the chord of a ſemicircle: it is called the *whole ſine*, *viz.* the greateſt of all.

The ſine B G, is call'd the *ſine-complement*, or *coſine*, of the arch B C; becauſe the arch B F, is the complement of the arch B C, to a quadrant; for C B F, is a quadrant of a circle in the ſame *figure*.

The *verſed ſine*, is part of the whole ſine, or radius, intercepted between the right line and the arch; as I C S is the *ſine* towards the arch B C, becauſe it is part of the ſemidiameter A C, intercepted between the arch B C K, the double of the arch B C, as its ſubtended B I K, in the ſame *fig.*

The *ſines* of obtuſe angles, are the ſame with thoſe of their complements to two right angles; and that all *ſines* of ſimilar arches have the ſame ratio to their radii.

The SEGMENT *of a circle*, is a part of the *circle* comprehended between an arch and the chord thereof. Or it is a part of a circle comprehended between a right line leſs than a ſemicircle, and a part of the circumference, as D L E, *fig.* 32. is the *leſſer ſegment*; and D E F the *greater ſegment*.

The *angle of a ſegment*, is that made by the tangent, and the chord carried through the point of contact; ſuch are the angles E B C, of the leſſer ſegment, and F B C, of the greater ſegment, *fig.* 32. where it muſt be obſerved, that the *ſegment* C A B, is call'd *alternate*, with regard to the angle of the ſegment C B E, as the ſegment C L B is call'd alternate, with regard to the angle of the ſegment F B C.

Angle in the ſegment, is that contained within two right lines, carried from the extremities of the chord to ſome point of the arch; as the angle B A C, on the ſegment B A C, *fig.* 33. This angle is call'd alſo angle to the circumference.

Angle at the periphery, is an angle whoſe vertex and legs do all terminate in the *periphery* of a circle, ſuch is the angle B D C, *fig.* 33.

The SECTOR of a *circle*, is that part of the circle, comprehended between two radii and the arch; ſuch is B C D, comprehended under the radii B D, and D C, and under the arch B L C.

Similar SEGMENTS, are thoſe which contain equal angles: thus the *ſegments* of the greater and leſſer circle will be ſimilar, if they contain equal angles: as the arch *e f g* in the leſſer circle, and B C D in the greater, are ſimilar, becauſe they contain the equal angles *e* A *g*, and B A D, *fig.* 34.

Equal circles, are thoſe whoſe diameters and radii are equal.

Firſt THEOREM. A diameter, perpendicular to the chord cut in two, *viz.* B D, *Fig.* 36. is divided into two by the diameter A F C; for the ſides B F and F D, being equal, by the definition of the circle, the triangle B F D is iſoſceles; therefore the angles in B and D are always equal to the baſe B D; but in the triangles B C F, D C F, the angle to C are right, becauſe of the perpendicular F C, which is alſo the ſide common to both: Therefore thoſe triangles are entirely equal; and conſequently the ſide B C is equal to the ſide C D, which was to be demonſtrated.

COROLLARIES. For the ſame reaſon it will be demonſtrated, that the right line which cuts perpendicularly the chord in two, is the diameter of the circle, or paſſes through the center; and the right which paſſes through the center, and divides the chord in two, is perpendicular to it.

The rights, without the center, do not divide themſelves mutually.

Second Theorem. If through the laſt term B of the diameter be carried D B, *Fig.* 37. perpendicular to the ſaid diameter, it will touch the circle in that ſole point.

For any other point of that perpendicular, *v. gr.* the point D will be out of the circle: And if the line A D be conceived drawn from the center A to the point D, there will be in the rectangular triangle the angle A B D greater than the reſt, to which the greater ſide is oppoſite, and which therefore is greater than the radius A B: And thus the point D falls out of the circle; which was to be demonſtrated.

Corollary. No right line can be drawn between the tangent and the circumference, through the point of the contact B, in the ſame *Fig.* without its cutting the circle. For let it be, if it be poſſible, B C, becauſe the angle A B D is a right angle, A B C will be acute: Therefore the drawn perpendicular A D, will be leſs than the Radius A B, which is oppoſed to the right angle; conſequently the point *d* falls within the circle.

Third Theorem. The angle at the center is twice the angle at the circumference, if they are both fixed to the ſame arch.

Three caſes may be conſidered in this Definition. The *firſt*, when one ſide of the angle on the circumference falls from one ſide of the angle at the center. The *ſecond*, when the ſides of the angles at the circumference include the angles at the center. The *third*, when the ſides of the angle at the circumference, and the angles at the center cut one another.

Let then the angles A B C, and A D C, in the firſt caſe, *Fig.* 38. be fixed to the ſame arch; I ſay that the angle A B C in the center is double the angle D in the periphery. For the angle ABC is external with regard to the triangle C D B. Therefore it is equal to two internal D and C; but theſe angles D and C are equal, when oppoſed to the Radii, or equal ſides, B C and BD: Therefore the angle A B C is double the angle D.

Likewiſe in the ſecond caſe, *Fig.* 39. the angle A B C is double the angle A D C: For if the line D B E be drawn paſſing thro' the center B, the angle A B E is double the angle A D E, and the angle E B C double the angle E D C, by the preceding demonſtration; therefore the whole angle A B C is double the whole angle A D C.

Laſtly, in the third caſe, *Fig.* 40. the angle A B C, is double the angle A D C; for, if the Line D B E, be drawn the whole angle C B E, by the preceding demonſtrations, is double the angle C D E. Likewiſe, the angle A B E is double the angle A D E: Theſe then being taken off, the angle A B C remaining, will be double the remaining A D C; which was to be demoſtrated.

Scholium. We have ſaid in the 8th definition, that the juſt meaſure of the angle placed in the center, is the arch comprehended between two radii. When then we ſay that the meaſure of any angle, *v. gr.* A D C, *Fig.* 38, 39. is this, or that arch, we underſtand that angle to be equal to the angle placed in the center; whereof this or that arch is the meaſure. Whence we make the following deductions.

Corollaries. The angle of the center A B F, *Fig.* 38, 39. fixed to the arch A F, is equal to half the arch A C, to which the angle A D C is fixed at the circumference: For the angle in the center A B C, is double the one and the other; and the whole arch A C, being the meaſure thereof, the arch A F, *i. e.* half A C, will be the meaſure of the angle A B F, and conſequently of the angle A D C, at the circumference.

The angles in the ſame ſegment A D C, A *d* C are equal between themſelves; every one being equal to half the angle A B C, placed at the center, or have the ſame meaſure, according to the preceding corollary, *viz.* half the arch A C, to which they are fixed.

The angle A D B, *Fig.* 41. in the ſemicircle, is a right angle; for its meaſure is a quadrant, or half of the circumference A E B, to which it is fixed. For the ſame reaſon, the angle A *b* D in the leſſer ſegment, will be obtuſe, and the angle A B D in the greater ſegment, acute; for that is fixed to the greater arch, and this to the leſſer. Therefore the meaſure of that will be an arch greater than half the circumference, and the meaſure of this a leſſer.

The oppoſite angles D and A, or I and E, inſcribed to the quadrilateral circle A I D E, *Fig.* 42. are equal, for the two arches to which are fixed the two oppoſite angles, take up the whole circumference, which is the meaſure of two right angles.

Fourth Theorem. The angle of the ſegment form'd by the tangent of the circle, and the chord carried through the point of the contact, is equal to the angle form'd in the alternate ſegment

For let the tangent F A G, *Fig.* 42 and the chord A D be drawn, I ſay that the angle F A D, is equal to the angle A E D, in the alternate ſegment; and the angle G A D equal to the angle A I D, likewiſe in the ſame ſegment; carried to the diameter A C B, the angle F A B will be a right angle. But the angle A D B in the ſemi-

circle

circle, is a right angle; therefore in the rectangular triangle A D B, the two angles D A B, D B A, are equal to a right one. But the ſame angle D A B, with the angle D A F, forms a right angle; therefore the angles D A F, and A B D, or A E D in the ſame ſegment, even an alternate one, are equal.

I ſay, that the angles G A D, and A I D, are equal; for in the quadrilateral A I D E, the oppoſite angles I and E, are equal to two rights. But the angle E is equal to the angle F A D, by the preceding demonſtration, then the angle I, will be equal to the angle D A G.

COROLLARIES. The meaſure of the angle of the leſſer ſegment F A D, is half the arch A I D, ſubtended by the chord A D, like the meaſure of the angle D A G, of the greater ſegment, is half of the arch A E D. The two tangents F B, F D, *Fig.* 43. are equal. For the chord B D joining the points of the contact, being drawn, the angles F B D, F D B, are made equal. The meaſure of both being the ſame, *viz.* half the arch ſubtended by the chord. Therefore an iſoſceles triangle is formed.

Fifth THEOREM. All *polygons*, circumſcribed by a circle, are equal to a rectangular triangle, one leg whereof is equal to the radius of the circle, and the other to the whole periphery of the polygon.

For in the indefinite right line A A, *Fig.* 45. let the baſes, A B, B D, *&c.* be taken, equal to the baſes into which the polygon is divided, *Fig* 46. then in the Point A, *Fig.* 45. muſt be drawn the perpendicular A C, equal to the radius C *g*. *Fig.* 45. *i. e.* equal to the altitude of the triangles contain'd in the polygon; and let C P be parallel to the baſe A A, that all the perpendicular lines, *c g*, *c b*, &c. *Fig.* 46. may be equal to one another, as well as to the radius *c g*, *Fig.* 45.

It is manifeſt that the white triangles A *c* B, B *c* D, &c. *Fig.* 45. are equal to the triangles *a c b*, *b c d*, &c. *Fig.* 46. into which the polygon is is divided. But to thoſe white triangles, are equal thoſe mark'd with black lines, *Fig.* 45. *e. gr.* the white triangle A *g c*, is equal to the black triangle A C *c*; and the white triangle B *c g*, to the black triangle B *n c*, &c. therefore the whole parallelogram A P, is double the white triangles.

But the ſame parallelogram A P, is double the triangle A A C; therefore the rectangular triangle A A C, the one leg whereof A A, is equal to the periphery of the polygon, and the other A C, equal to the radius *c g*; that rectangular triangle A A C, ſays I, is equal to the white triangles 45, and conſequently to the whole polygon 44.

Sixth THEOREM. All ordinate, or regular polygons, (formed of the equal chords of a circle) drawn in a circle, are equal to the rectangular triangle, one leg whereof is equal to the periphery of the polygon, the other to the perpendicular *c g*, *Fig.* 46. carried from the center *c*, to either ſide of the polygon, *a b*.

The demonſtration is the ſame as that of the preceding theorem.

COROLLARY. As a polygon of almoſt infinite ſides, can be circumſcribed or inſcribed by a circle; it follows hence, that their perimeters can attain *in infinitum*, the circumference of the circle, tho' the perimeter be always greater than the circumference of the circumſcribed circle, and leſſer than that of the inſcribed.

But the polygon circumſcribed by a circle, is equal to a rectangular triangle, one leg whereof is the radius of the circle, and the other the perimeter of the polygon; for a polygon formed within a circle, is equally equal to a rectangular triangle, one leg whereof is the perimeter of the polygon, and the other a perpendicular drawn from the center of the circle to any ſide of the polygon. Therefore the circle will be likewiſe equal to a rectangular triangle, one leg whereof is equal to the radius, and the other to the circumference of the circle; as demonſtrated by *Archimedes*, in his ſmall book of the dimenſion of the circle.

SCHOLIUM. Though the perimeter of a polygon, either drawn round a circle, or within a circle, may attain *in infinitum*, to the magnitude of the circumference of the ſame circle, it notwithſtanding never becomes equal to it. Whence, by that method, we can never have a line equal to the circumference of a circle; *in which conſiſts the difficulty of the* QUADRATURE OF THE CIRCLE, for if we could find that line, we could form a rectangular triangle, equal to the circle; and a parallelogram equal to that triangle; and a quadrate equal to that parallelogram. As I'll ſhew by the problems relating to this ſubject.

Of the SOLIDS. Solid is a magnitude endued with three dimenſions, length, breadth, and depth.

The extremity of the *ſolid*, is the ſuperficies; that of the ſuperficies, a line; and that of a line, a point.

As a plane angle conſiſts of right lines drawn on a plane ſuperficies, likewiſe a *ſolid* angle conſiſts of ſeveral plane angles, but which are not placed on the ſame plane.

Therefore a *ſolid* angle is rectilinear, and is form'd by three or more plane angles B O A, C O A, *&c.* or D O E, E O E, *Fig.* 47. not

placed in the same plane, but meeting in the point O.

A *prism* is an oblong *solid*, contain'd under more than four planes, and whose two bases ABC, and O E F, or G H, and K L, are equal, parallel, and alike situated; and the rest parallelograms.

The prism is generated by the motion of a rectilinear figure, descending always parallel to itself, along a right line.

If the describent be a triangle, the body is said to be a *triangular prism*; if a square, a *quadrangular one*, &c.

From the genesis of the *prism*, it is evident it has two equal, and opposite bases; that it is terminated by as many parallelograms, as the base consists of sides; and that all the sections of a prism parallel to its base, are equal.

A *parallelopiped* is one of the regular *solid*, comprehended under six parallelograms, the opposite ones whereof are similar, parallel, and equal; as K O L P G H I, *Fig.* 49. Therefore all parallelopipeds are prisms, but all prisms are not parallelopipeds.

If a regular *solid* consists of six squares and equal faces, or sides, and its angles all right, and therefore equal, it is a cube. Whence all cubes are parallelopipeds, but all parallelopipeds are not cubes.

The *Pyramid*, A B C *o*, or D E F *o*, *fig.* 47. is a solid standing on a square, triangular, or polygonal basis, and terminating at top in a point; or a body whose base is a regular rectilinear figure, and whose sides are plain triangles; their several vertices meeting together in one point.

Euclid defines it a solid figure, consisting of several triangles, whose bases are all in the same plane, and have one common vertex.

Therefore the plane A B C, is called the *basis* of the *pyramid*; and may be either a triangle, or a quadrangle, or any other figure, from each side whereof triangles are rais'd to the point O, which is called the vertex; from whence the perpendicular O I falling, it measures the height of the pyramid.

If without the plane of some circle C F, *fig.* 51. from which the indefinite right line O F be drawn, touching the circle in F; and which, the point O remaining fix'd, may be turn'd round the periphery of the circle, till it returns to the place O F, whence it begun to move: the superficies, describ'd by the right line F, will be conical; and the body contain'd in that superficies, and the circle, call'd a *cone*. O is the vertex of the cone; the circle C F its basis; the right line O I, drawn from the vertex to the base, its axis; and the right line drawn from the vertex to the circumference of the basis, the side of the cone.

A cone may be cut in five different manners, 1. By a plane through the vertex A G B, *fig.* 55. and the triangle A G B is made. 2. By a plane, parallel to the base, and a circle is form'd. 3. By the plane F S F, parallel to the side of the cone A G, and this section is called *parabola*. 4. By the plane K L R, which passes through the vertex of the cone, without the superficies thereof, that is neither cutting, nor touching it: and the cone being again cut by another, parallel to the former; and this section is called *ellipsis*. 5. By the plane E Q D, which cut the cone any how through the vertex, and by another plane parallel to the former plane; then the section made in the superficies thereof is called an *hyperbola*. But when geometers mention *conick sections*, none must be understood but the *parabola*, *ellipsis*, and *hyperbola*.

A parabola is defin'd a figure arising from the section of a cone, when cut by a plane, parallel to one of its sides. From the same point of a cone, therefore only one parabola can be drawn; all the other sections within those parallels being ellipses, and all without hyperbola's. *Wolfius* defines the parabola to be a curve wherein $a x = y^2$, that is, the square of the semi-ordinate, is equal to the rectangle of the *abscisse*, and a given right line, called the parameter of the axis, or *lacus rectum*. Hence a parabola is a curve of the first order; and as the abscisses increase, the semi-ordinates increase likewise; consequently the curve never returns into itself. Hence, also, the abscisse is a third proportional to the parameter, and semi-ordinate; and the parameter a third proportional to the abscisse, and semi-ordinate; and the semi-ordinate a mean proportional between the parameter and abscisse.

The *ellipsis* is thus called from the square O T of the ordinate O R, *fig.* 57. being equal to the rectangle A S; which applied to the parameter A P, is deficient from the rectangle O P, comprehended under part of the axis O A, and under the parameter A P, all these are determined thus: as the greater axis I A, is to the lesser axis M N of the ellipsis, M N is to the parameter A P of the greater axis. Therefore the perpendicular A P being drawn to the extremity of the diameter I A, the triangle I P is formed, which is called the *figure of the axis* I A; the diameter of I P thereof will occur to the diameter I A of the ordinate line O R, and produced in S if it be necessary: whence will be formed the rectangle A S, equal to the square O T of the ordinate O R. But that rectangle A S falls from the rectangle contained under part of the angle A O, and the whole parameter A P. It falls, I say, by the small rectangle S P, which is semblable to the figure I P. If from the extremity N, of the

leſſer axis N M, be deſcribed the arch F *f*, by the interval N *f*, equal to the greater ſemi-axis C I, the points F *f* will be the foci of the ellipſis; becauſe the ellipſis is a figure, every point of the circumference whereof, are diſtant in ſuch a manner from the foci, that the two diſtances F N, F N, or *f* n, *f* n, taken together are always equal to the whole greater axis I A.

The *ellipſis*, to define it from its form, is a regular continued curve line, including a ſpace that is longer than it is broad, wherein are two points equally diſtant from the two extremes of the length; from which two right lines being drawn to any point, aſſumed at pleaſure in the *ellipſis*, their ſum is equal to the length of the *ellipſis*.

Laſtly, the *hyperbola* is thus called from the ſquare O T, of the ordinate O R, *fig.* 58, being equal to the rectangle A S, which applied to the parameter A P, exceeds the rectangle, made under part of the axis A O, and the parameter O P, by the rectangle P S, becauſe the figures V P are ſemblable to the hyperbola B A D, and N V X are called oppoſite; the point C is their center. The line A V is the *determinate axis*, to which the other undeterminate axis may be carried at right angles. The points F *f*, are the foci of the conter-placed *parabola's*, which are placed in ſuch a manner, that the line F N, drawn from one focus, at the point N of the hyperbola, will always exceed the other line F N, drawn from the other focus to the ſame point N, by the bigneſs of the determinate axis A V; the right line C X C Y, which drawn thro' the center C, can never occur to the oppoſite ſections, are called *aſymptotes*.

If round thoſe equal circles, and the parallels B B, C C, *fig.* 55, the indefinite line B C be turned till it returns to the place whence it began to move; ſo that, while it moves, it remains always parallel to itſelf, the ſuperficies deſcribed by the right line B C is called *cylindrical*; and the body contained within that ſuperficies, and two circles, a *cylinder*. The baſes of the *cylinder* are the ſaid two circles; the axis is the right line O I, joining the centers of the baſes; and the ſide of the *cylinder*, is the right line B C, touching both baſes, in the ſuperficies of the cylinder.

The *ſphere* is a ſolid body, contained under one ſingle ſurface, and having a point in the middle, called the *center*; whence all lines drawn to the ſurface are equal. The point C is called the center of the ſphere, *fig.* 59. the diameter of the ſphere is the right line O I, drawn through the center, producted and carried to the ſuperficies, ſo as to attain to both extremes; one half whereof is the ſemidiameter C O, called alſo radius.

If a globe, or the greater circle A E B D of a globe, *fig.* 60. be moved on the right line D F, ſo as for its center C to deſcribe, by an uniform motion, the line C H, then the point D will be moved, in ſuch a manner, by a motion, compoſed of a right and a circulary, as to deſcribe the curve D *d d d d d f*, called *Cycloïs* or *Trochoïs*, which are of great uſe in the oſcillatory clocks, to regulate the motion of the pendulum: there is another line between that, and marked with points, which is called the *companion* of the *trochoïs*.

Thoſe are called regular bodies, which are terminated on all ſides by regular and equal planes, and whoſe ſolid angles are all equal. Theſe regular bodies are five in number, *viz.* the *cube*, C *c*, *fig.* 62, 63. which conſiſts of ſix equal ſquares; the *tetrahedron*, T *t*, *fig.* 61. of four equal triangles; the *octahedron*, O *o*, *fig.* 64, 65. of eight; the *dodecahedron*, D *d d*, *fig.* 66. of twelve; and the *icoſithedron*, I *i*, *fig.* 67. of twenty.—beſides theſe five, there can be no other *regular* bodies in nature.

Of PROPORTIONS. When two magnitudes of the ſame genus are compared between themſelves, the firſt term of compariſon is call'd *antecedent*, the ſecond *conſequent*.

That comparation, or relation, can be made in two different manners; *viz.* when we conſider by how much one of thoſe quantities exceeds the other, or is exceeded by it; and that habit is call'd *exceſs*, or difference: Or when it is aſked, how many times, or how one is included in the other, or contains it? and ſuch habitude is commonly call'd *ratio*.

If the firſt *quantity* contains twice the ſecond, the firſt is ſaid to be the ſecond in a *double ratio*; if thrice, in a *triple ratio*; if four times, in a *quadruple ratio*, &c. and that contained, is ſaid to be in a *ſubduple*, *ſubtriple*, *ſubquadruple*, &c. as a line of eight feet, is to a line of four feet, in a *duple ratio*; and a line of four feet, to a line of eight feet, in a *ſubduple ratio*.

If there be ſeveral magnitudes, the firſt of which has the ſame *ratio* to the ſecond, as the ſecond to the third, and the third to the fourth; then the firſt is ſaid to have a *ratio duplicate* of that, it has to the ſecond; likewiſe it is ſaid to have to the fourth a *ratio triplicate* of that it has to the ſecond: That if there be four lines, the firſt of which be of ſixteen feet, the ſecond of eight, the third of four, and the fourth of two; if you ſearch the *ratio* of the firſt line of ſixteen feet to the ſecond of eight feet, I ſay that it is *double*, or *duple*, or as 2 to 1; and if the *ratio* of the firſt of 16, to the third of 4 feet, I ſay that it is twice *duple*, becauſe compoſed of the *ratio* of the firſt line of 16, to the ſecond of 8 feet, which is *duple*; and of the *ratio* of the ſecond, *viz.* 8, to the third 4,

which

which is also *duple*; whence the *ratio* of the first to the third, is *duplicate* of the *ratio* of the first to the second; or is twice *duple*, or rather *quadruple*. Now the *ratio* of the first to the fourth, or of 16 to 2, is *triplicate* of the *ratio*, of the first to the second. Therefore it must be composed of the *duple ratio*, which is of the first to the second; and of the *quadruple ratio*; which is of the same first to the third, and thus it is twice *quadruple*, or rather *quadruple*.

If the first line has more magnitude comparatively to the second, than the third to the fourth, the first would be said to have a *greater ratio* to the second, than the third to the fourth; and the third to have a *lesser ratio* to the fourth, than the first to the second, which is a familiar manner of speaking to geometers.

Therefore all things which have the same ratio to a third, are equal; and those things are equal to such as they have one and the same *ratio*.

If a quantity, *v. g* a bipedal line, has some relation to another, *viz.* a pedal line, in whatever manner the first be multiplied, or divided, it will always have the same *ratio* to the second, if the second be likewise multiplied or divided in the same manner: For as a bipedal line is to a pedal line, so is a line of four feet to a line of two feet; or so is a line of one foot, to a semipedal line, &c.

These magnitudes, thus multiplied by equality, are call'd *æque-multiple* of their simples.

Proportion is the identity, or similitude, of *ratio's*, of differences, or excesses. The first is call'd *geometrical proportion*, and the second *arithmetical*; but however, when we only mention the name of proportion, the *geometrical proportion* must always be understood, as the most essential.

Therefore as every *ratio*, or difference, requires necessarily two terms, viz. *antecedent* and *consequent*; every *proportion* requires four such terms. The first is called *first antecedent*; the second *first consequent*; the third *second antecedent*; the fourth *second consequent*. The first and last are call'd the *extremes*, and the second and third *medii*. They are marked in this manner: 4, 2 :: 6, 3 *i. e.* 4 is to 2, as 6 is to 3; or a line of four feet is to a line of two feet, as a line of six feet to a line of three feet. Those four terms are *analogous*, or *proportional*; and that the *proportion* is call'd *geometrical*, which is an equality of ratio's. The following *proportion* is *arithmetical*; 4, 3 :: 2, 1. because the *excess* of the *first antecedent* is the same with respect to the *first consequent*; as that of the *second antecedent*, with respect to the *second consequent*.

The second term does, sometimes, the office of the *antecedent* and *consequent*, in this manner, — 8, 4, 2. *i. e.* as 8 is to 4, so 4 is to 2; or as a line of 8 feet is to a line of 4 feet: so the same line of 4 feet is to the line of 2 feet. In which *proportion*, which is call'd *continued*, the line of four feet is *consequent*, with respect to the first *antecedent*; and *antecedent*, with respect to the second *consequent*; and this may happen both in the *arithmetical* and *geometrical proportion*.

The line of 4 feet, or any other quantity, which is the middle between two, is call'd *middle proportional*; and this either *geometrically* or *arithmetically*.

A series or progression, of more than four *geometrical proportions*, is call'd a *geometrical progression*.

If three quantities be in continual *geometrical proportion*, the product of the two extremes is equal to the square of the middle term; thus, in 6 : 12 : : 12 : 24, the product of 6, and 24, is equal to the square of 12, *viz.* 144. Hence we have a rule.

To find a mean *geometrical proportional* between two numbers, *e. gr.* 8 and 72; multiply one of the numbers by the other, and from the product 576, extract the square root 24; this will be the mean required: more of this in the theorems.

The third species of *proportion*, is the *harmonical proportion*, which is often mentioned by the antient mathematicians. This *proportion* consists in three terms, so disposed, that as the habit of the greater is to the lesser, such is the habit of the difference of the greater from the lesser, to the difference of the middle from the lesser, *v. gr.* let the numbers be 12, 8, 6; as the greater term 12 is to the lesser 6, so is 4 the difference of the greater term 12 from the middle 8, to 2, the difference of the middle 8 from the lesser 6 for as the greater term 12 contains twice the lesser 6, so the difference 4, which intercedes between 12 and 8, contains twice the difference 2, which intercedes between 8 and 6.

For the same reason, 6, 4, 3, or 6, 40, 30, are in the *harmonical proportion*.

Between the sides of the figures, several *ratio's* or *excesses* can occur, whereby the habit of one figure to the other may be made apparent.

A line is carried into another, or is multiplied by another, when a rectangular parallelogram is made of both. Those two lines being the two contiguous sides thereof; as the line LM is carried into the line L I, when the rectangular parallelogram, I K L M, *Fig.* 9. is made of both.

If the line AB, *Fig.* 12, be carried into itself, or into a line equal to itself, *viz.* if C D be equal to A B, and be multiplied by the line C E, equal to itself, from that multiplication will arise the square E F C D, for all its sides will be equal.

A rectangle, or any other superficies, is multiplied by a line, when of that superficies and line is formed

formed a rectangular parallelopiped, whose base be that superficies; and the perpendicular altitude be that line. Thus *v. gr.* the superficies ABDH, *Fig.* 55, multiplied by the line IK, or by the line BE equal to it, makes the solid FA, whose base is the superficies ABDH, and the altitude KI, or BE equal to it.

If that superficies be square, and multiplied by a line equal to every one of its sides, there will arise a *cube*, every face whereof will be equal between themselves, as demonstrated by the same figure.

Of rectilinear figures those are said to be similar, which have every angle equal to every others, and their sides proportional to equal angles; such are the triangles ABC, and *a b c*, *Fig.* 68, 69, for the angle A is equal to the angle *a*, &c. and as the side AB is to AC, so is the side *a b* to *a c*, &c. such sides which answer to themselves in the proportion, are called *homologous*, as AB and *a b*, AC and *a c*, &c.

The altitude of any figure, is a perpendicular line drawn from its vertex to its base; as AP, *Fig.* 68. is the altitude of the triangle ABC.

The spaces, or intervals, comprehended between the parallels are equal, if their perpendiculars be drawn equal.

First THEOREM. In an *arithmetical proportion*, the sum of the extreme terms, is always equal to the sum of the middle terms.

As in this *arithmetical proportion*, 4 . 3 : : 2 . 1, the additional of the extremes, *viz.* 4 and 1 make 5, likewise the middle terms 3 and 2 added together make up 5, and this is easily understood; because, for as much 3 is surpassed by 4; as much 1, which is joined with 4, is surpassed by 2, which is put with 3; therefore the equality is perfect every where.

Second THEOREM. But in the *geometrical proportion*, the multiplication of the extremes, is equal to the product of the middle terms.

As in this proposition 4 . 2 : : 6 . 3, if you multiply 4 by 3, or 2 by 6, you'll have 12. The reason is, because 4 and twice 2 are the same thing; the same as 6 and twice 3 are the same thing. When, therefore, you multiply 3 by 4, it is the same as if you was to take twice 3 and twice 3, or rather four times 3; when, likewise, you multiply 2 by 6, it is the same as if you was to say twice 3, and twice 3. When the product is equal every where. See *Fig.* 70.

COROLLARY. If the proportion be continual, the product of the middle term, by itself, *i. e.* its square, will be equal to the rectangle of the extremes.

SCHOLIUM. Therefore as often as the product of the extremes will be found equal to the product of the middle terms, so often four terms will be in *geometrical proportion*. And this will always happen in the following permutation of terms: For if it be,

4 . 2 : : 6 . 3,

It will be by inverting 2 . 4 : : 3 . 6.

By alternating 4 . 6 : : 2 . 3.

By compounding 4 . + 2 . 2 : : 6 . + 3 . 3.

By dividing 4 . — 2 . 2 : : 6 — 3 . 3.

Third THEOREM. The sides of triangles equiangle, are proportional with respect to equal angles, and *viciffim*.

Let ABC, *a b c*, *Fig.* 68, 69. be the triangles equiangle; I say that AB is to *a b*, as AC to *a c*, and BC to *b c*; and alternating thus, AB to be to AC, and BC, as *a b* to *a c* and *b c*.

Let the perpendicular AP in the greater triangle, fall from the vertex A, and be divided into so many equal parts, *v. gr.* 7; and through each division let right lines be drawn parallel to the base BC, which will occur to the side AB, in the points FG, &c. from every one of which must be let fall, likewise, perpendicular on the base, or rather on the part BP of the base, it is manifest that the side AB, and the part BP, of the base, are divided into so many parts, as are contained in the perpendicular AP, which parts will be every one equal between themselves, as well in AB as in BP.

Likewise a perpendicular being drawn in the lesser angle *a p*, in which must be taken the parts *a d*, *d e*, &c. equal to the parts AD, DE, &c. and five must be contain'd in *a p*, like the seven found in AP, and through each division *d e*, &c. let right lines be drawn parallel to the base *b c*, which will occur to *a b*, in the points *f g*, &c. from every one of which must be let fall perpendiculars on the base, or part of the base *b p*, it is clear that the side *a b*, and part of the base *b p*, are divided into so many parts equal between themselves, as are contain'd in the perpendicular *a p*.

Therefore the number of equal parts of the perpendicular AP, in the greater triangle, is to the number of parts of the perpendicular *a p* in the lesser triangle, as the number of parts of the side AB, or of the base BP, is to the number of parts of the side *a b*, or of the base *b p*.

The same will be demonstrated of the triangles APC, *a p c*; and therefore as the side AP is to the side *a p*, so is the side *a c*, and PC, to *p c*; and consequently as the whole base BC, is to the whole base *b c*; which was to be demonstrated.

Fourth THEOREM. In rectangular triangles, a perpendicular let fall from the right angle on the base, makes two triangles equal to one another, and to the whole, *v. gr.* the perpendicular AD, *Fig.* 71. makes the triangles DAB and DAC, similar to one another, and to the whole triangle CAB.

For

For in the triangles CAB and DAB, the two angles C A B, which is a right angle, and A B C, are equal to the two A D B, which is alſo a right angle, and AB D. Therefore the third A C B, is equal to the third D A B; and therefore thoſe triangles are equiangles; and conſequently have their ſides proportional.

Firſt COROLLARY. The perpendicular AD, in the ſame figure, is a middle proportional, between the ſegments of the baſe CD and DB, *i. e.* as CD is to D A, ſo is D A to D B. For the triangles C A D and D A B, being equal, likewiſe as C D the leſſer angle of the triangle CAD is to DA, the greater angle of the ſame triangle, as DA the leſſer ſide of the triangle D A B, is to D B the greater ſide.

In the ſame manner CA is a middle proportional, between the hypothenuſe C B, and the ſegment C D; for the triangles C A B and C A D being equal, the hypothenuſe C B, in the greater angle C A B, will be to the leſſer ſide C A, as the hypothenuſe C A in the leſſer triangle C A D, is to its leſſer ſide C D.

Laſtly B A is a middle proportional between the hypothenuſe B C and the ſegment B D. For the triangles B A C and B A D being equal, the hypothenuſe B C in the greater angle BAC, will be to BA the greater ſide, as the hypothenuſe B A in the leſſer triangle B A D, is to its greater ſide B D.

Hypothenuſe, (from ὑποτείνω, *ſubtendo*, I ſubtend) in *geometry*, is the longeſt ſide of a right angled triangle; or that ſide which ſubtends, or is oppoſite to the right angle.

Segment, is a part of a circle, comprehended between an arch and the chord thereof. Or it is part of a circle comprehended between a right line leſs than a ſemicircle, and a part of the circumference.

Second COROLLARY. The ſquare of the perpendicular A D, in the ſame figure, is equal to the rectangle contain'd under the ſegments of the baſe B D, and D C, becauſe it is a middle proportional between thoſe ſegments. By the ſame reaſon the ſquare of the ſide CA is equal to the rectangle made of the baſe B C, and its ſegment C D: Likewiſe the ſquare of the ſide BA, is equal to the rectangle comprehended under the baſe BC, and its ſegment BD.

Fifth THEOREM. In all rectangle triangles, the ſquare of the baſe, or hypothenuſe BC, is equal to the ſides of the ſquares BA, and A C taken together. *Fig.* 71.

For the ſquare B M, muſt be divided into the two rectangles B E, and C E, by the production, or carrying on the perpendicular AD into E. The triangle B E, being contained under the baſe B C, or rather under B N, equal to itſelf, and under its ſegment B D; ſo that it is equal to the ſquare of the triangle B A.

For the ſame reaſon, the rectangle C E, contained under the baſe B C, or rather under C M, equal to itſelf, and under CD, is equal to the ſquare of the ſide AC; and thus the whole ſquare BM, is equal to the ſquares of the ſides B A and AC, taken together.

SCHOLIUM. This great and curious *theorem*, which is the 47th propoſition of *Euclid*'s elements, is attributed to *Pythagoras*.

Among the different uſes this problem is of, in the mathematicks, I'll mark two principle ones, which all philoſophers ſhould be perfectly acquainted with.

For, firſt, it is demonſtrated by it, that there are ſome lines which are *incommenſurable*, i. e. lines between which no common meaſure can be found; or which are not between themſelves, as a number to another number; for all numbers have at leaſt unity for common meaſure; from a repetition whereof they proceed.

Therefore, let us ſuppoſe in the rectangular triangle A B C, *Fig.* 71. the ſide A C to be of three feet; the ſide A B of four feet; and the hypothenuſe B C, of five feet: it follows hence, that the ſide of the ſquare A C, *viz.* A H, contains nine ſquare feet; becauſe the ſquare of a line is made of that line, being carried into itſelf, or multiplied in itſelf. But if three feet be taken thrice, or multiplied by a ternary number, they will form nine feet. Likewiſe the ſquare of the ſide A B, *viz.* A F, will be of ſixteen feet; and the ſquare of the hypothenuſe B C, *viz.* B M, will contain twenty-five ſquare feet. Then if the ſquare A H, 9, and A F, 16, be added together, they will make 25; becauſe together they are equal to the ſquare B M, which comprehends alſo, twenty-five ſquare feet. And not only thoſe ſquares are expreſſed by numbers, but even their roots, or ſides, can be expreſſed by numbers. For all thoſe numbers, which multiplied by themſelves, form a ſquare, are called the roots or ſides of ſquares. As 2 is the root of the ſquare 4, for 2 taken twice, make up 4; thus 3 is the root of the number 9; 4 is the root of 16; 5 the root of 25; 6 the root of 36; 7 the root of 49; 8 the root of 64; 9 the root of 81; 10 the root of 100, *&c.* Thoſe numbers 4, 9, 16, 25, 36, 49, 64, 81, 100, are ſquare, becauſe they ariſe from certain numbers carried into themſelves, and their unity can be diſpoſed in a ſquare form. Thus nine unities can be diſpoſed in a ſquare, each ſide whereof will contain three unities. Likewiſe ſixteen unities can be diſpoſed in a ſquare form the ſide whereof will conſiſt of four unities. The ſame

may

may be ſaid of the following numbers 25, 36, 49, &c. But if numbers cannot be diſpoſed in a ſquare, they are not to be called ſquares.

Therefore a number which is duple of a ſquare one, cannot be ſquare, becauſe it cannot be diſpoſed in a ſquare form, *v. gr.* if a quarternary number be taken twice, it becomes octonary, which is not a ſquare, becauſe it cannot be diſpoſed in a ſquare form. But if the quarternary number be taken four times, it will produce 16, which is a ſquare.

But though a ſquare number cannot be the duple of another ſquare number; a ſquare extended, notwithſtanding, can be the duple of another extended ſquare. For if the rectangular triangle was iſoſceles, *v. gr.* if both its legs were of four feet, the ſquare of either leg would be of 16 feet, and both taken together conſiſt of 32 ſquare feet; ſo that the ſquare of the hypothenuſe of that triangle would contain 32 feet, and be the duple of one another.

The number 32 is not ſquare, but is contained between the ſquare numbers 25 and 36; whoſe roots are 5 and 6, ſo that the root of the number 32, which is the hypothenuſe of the propoſed triangle, and marked thus R 32, muſt contain more feet than 5, and leſs than 6; but the magnitude of that number cannot be preciſely determined; neither can the foot, or any part of the foot which meaſures the ſides, be the common meaſure of their ſides, and hypothenuſe. Therefore the hypothenuſe of the rectangle iſoſceles triangle, ſuch as the diagonal of any ſquare, is *incommenſurable*. *Peripateticians* make uſe of this argument, to prove that the matter is diviſible, *in infinitum*.

But there is another uſe of this theorem, which can never be prized too much, *viz.* the conſtruction of the tables of *ſines*, *tangents*, and *ſecants*; of which conſtruction I will give an example. Having deſcribed the circle A E D F B C K, *fig.* 35. and the radius A B being applied to the circumference from B into K, and the ſide A K drawn, the triangle B A K, will be equilateral; and thus all its angles will be equal between themſelves, or each of them will be of 60 degrees. Therefore the ſide or chord B K, being in two equal parts, the arch B C will be of 30 degrees.

But becauſe the radius is commonly put of 10000000 parts, the chord B K equal to it, will be of ſo many parts: therefore its half B I, which is the *ſine* of the arch B C, will be of 5000000 parts.

But then in the rectangular triangle A I B, the ſquare of the hypothenuſe A B, is equal to the quadrates of the ſides A I, and B I, taken together. Therefore let the ſquare of the hypothenuſe A B, be made by carrying 10000000 into 10000000, it will be 100000000000000, then from this product, take off the ſquare of the ſide B I, *viz.* 25000000000000, there will remain the ſquare of the ſame A I, or of G B, the ſine of the complement 75000000000000, from which if the ſquare root be extracted, we ſhall have the line A I of almoſt 8660254 parts.

Beſides, as the triangles A B I, and A H C are ſimilar, let it be that as A I to B I, ſo A C to C H, the tangent C H ſhould be had. That if the ſquares of the ſides A C and C H be added together, we will have the ſquare of the hypothenuſe A H; from which if the root be extracted, then that hypothenuſe A H, which is the ſecant of the arch B C, will appear.

I will finiſh here, that part of *Geometry*, which I call *ſpeculative*; and paſs to *practical Geometry*.

DEFINITIONS.

ORGYIA, was an ancient *Grecian* meaſure, containing ſix of our feet. Some repreſent the *Orgyia*, as the *Grecian* pace. *Heſychius* deſcribes it as the ſpace comprehended between the two hands, when the arms are extended, anſwering to the *Roman ulna*, and our fathom.

The foot contains twelve ounces, or inches; for the one is not only taken for a weight, in which ſenſe it is a twelfth part of a pound; but likewiſe for a meaſure, in which ſenſe it is a twelfth part of a foot; as a digit is a ſixteenth part of a foot. Which, notwithſtanding, the authors of our time, take indifferently the inch and digit, for a twelfth part of a foot; ſo that when it is a queſtion of an eclipſe of the moon, the name of digit is taken for a twelfth part of the apparent diameter of the moon. Therefore when it is ſaid that the eclipſe of the moon is of two or three digits, it is the ſame as if it was ſaid, that it is of two or three twelfth parts of its apparent diameter.

The foot conſiſts of twelve parts, which we call lines. The antients had other meaſures which are not in uſe among us.

The meaſures common to the *Romans*, and the *Gauls*, are expreſſed in the following verſes:

*Quatuor ex granis * digitus componitur unus,*
Ex quater in palmo digitus; quater in pede palmus.

* By corn is underſtood here *barley-corns* placed length-wiſe, againſt one another; and by paces are underſtood geometrical paces, each conſiſting of three feet.

Quinque pedes ‡ *paſſum faciunt; paſſus quoque Centum.*
Vigenti quinque, ſtadium dat, at Miliare
Octo dabunt ſtadia: duplicatum dat tibi Leucam.

The *Engliſh* foot being divided into one thouſand parts, or into twelve inches, the other feet will be as follows:

		Th. Pts. F. In. lin.
London	Foot	1000 0 12 0.
Paris, the Royal		1068 1 00 8.
Amſterdam		942 0 11 3
Antwerp		946 0 11 2
Dort		1184 1 02 2
Rhineland, or *Leyden*		1033 1 00 4.
Lorrain		958 0 11 4
Mechlin		919 0 11 0
Middleburg		991 0 11 9.
Straſburg		920 0 11 0
Bremen		964 0 11 6.
Cologn		954 0 11 4.
Francfort on the *Mayne*		948 0 11 4.
Spaniſh		1001 0 12 0
Toledo		899 0 10 7
Roman		967 0 11 6
Bononia		1204 1 02 4
Mantua		1569 1 06 8.
Venice		1162 1 01 9
Dantzick		944 0 11 3
Copenhagen		965 0 11 6
Prague		1026 1 00 3
Riga		1831 1 09 9.
Turin		1062 1 00 7
Greek		1007 1 00 1.
Paris, by Dr. *Bernard*,		1066 1 00 1.
Old Roman		970 0 00 0.

The *Paris* foot being ſuppoſed to contain 1440 parts, the reſt will be as follows;

Paris	Foot	1440.
Rhineland		1391.
Roman		1320.
London		1350
Swediſh		1320
Daniſh		1403
Venetian		1540$\frac{2}{3}$
Conſtantinopolitan		3120.
Bononian		1682$\frac{1}{3}$
Straſburg		1283$\frac{1}{4}$
Norimberg		1346$\frac{1}{4}$
Dantzick		1721$\frac{1}{2}$
Hall		1320.

First Problem. In the given point of the right line, to form an angle equal to the other given.

Let B of the line AB, *Fig.* 72. be the point in which is to be formed the angle, equal to the given angle CDE, *Fig.* 73.

From the point D muſt be deſcribed the arch CE; then the ſame aperture remaining, the arch HG muſt be made from the point B, from which muſt be cut the arch HF, equal to the arch CE, and the line BF drawn; then the angle ABF, will be equal to the angle CDE, becauſe thoſe two angles are meaſured by the ſame arch.

Second Problem. To draw a perpendicular from the point given in a line.

Let the point C be given in the line AB, *Fig.* 74. from which is taken on each ſide the equal parts CD, CE; and from the points D and E be deſcribed arches, cutting each other in the point I; then from the point C, through the point I, let the line CO be drawn, which will be the perpendicular required. Becauſe the point I, does not incline more towards the part DA, than towards the part EB, and *viciſſim*.

Third Problem. From the point given without a line, to carry a perpendicular to that line.

Let C, *Fig.* 75. be the point given, from which is deſcribed the arch DE, cutting the line A in the points D and E; from theſe points D and E, let two arches be made, cutting one another in the point F; and the line CF be drawn to cut the line AB in O; then the line CO will be the perpendicular required; becauſe it is not more inclined towards the part DA, then towards the part EB.

Fourth Problem. Through the point given, to draw a parallel to the line given.

Let A, *Fig.* 76. be the point given, through which is to be drawn a parallel to the line given CB, let the right line AD be drawn cutting the right line given CB in D; and from the point D be deſcribed the arch AF, and from the point A, at the ſame interval, be deſcribed the other arch DE, into which the arch AF is to be transferred, *viz.* from D into G; then the right line AG will be the parallel required; becauſe the alternate angles ADF, and DAG are equal.

Fifth Problem. Between two lines given to find a *middle proportional*.

Let D, BDC, *Fig.* 78. be the lines given, placed in a direct line, and form the right one BC, from whoſe middle point E muſt be deſcribed the ſemicircle ABC, then from the point D will be drawn the perpendicular DA, meeting with the

‡ The foot is of different lengths in different countries. The *Paris Royal* foot exceeds the *Engliſh* by ſeven lines and a half; the antient *Roman* foot of the capital, conſiſted of four palms, equal to eleven inches, and ſeven tenths *Engliſh*: the *Rhineland*, or *Leyden* foot, by which the northern nations go, is to the *Roman* foot, as 950 to 1000. The proportions of the principal feet of ſeveral nations, compar'd with the *Engliſh* and *French*, are as above.

circum-

circumference in A; I ſay, that ſuch line is the middle proportional between BD, and DC.

For the lines BA and CA being drawn, the angle BAC is formed in the ſemicircle, and conſequently is a right angle; therefore the perpendicular AD, being let to fall on the baſe BC is the middle proportional, between the ſegments, or lines given BD, DC.

SCHOLIUM. By finding two *propartionals* between two lines given, the famous problem of *Delos* of the *duplication of the cube* is executed; and that you may have ſome notion how it is done, it muſt be underſtood that a ſquare is made of any quantity, *viz.* a number, or a line multiplied by itſelf, the ſide or root thereof is that ſame quantity; then if the ſquare be multiplied by the ſame root, there will ariſe a cube, whoſe ſide or root is the ſame quantity. For example, if you multiply 2 by 2 it will produce the ſquare 4, whoſe root is 2. Again, if the ſquare 4 be multiplied by the root 2 it will produce the cube 8, whoſe root is the ſame number 2; Likewiſe, if you carry 4 into 4 you'll produce the ſquare 16, which ſquare being multiplied by 4, will give the cube 64.

But if there be four quantities continually proportional, ſuch as 2.4::8.16, the cube of the firſt is to the cube of the ſecond, as the firſt is to the fourth; for 2 is to 16, as 8 the cube of the ſaid 2, is to 64, the cube of the ſaid 4. becauſe as 2 is the eighth part of the number 16; ſo 8 is the eighth part of the number 64.

Therefore if two lines were given, the laſt whereof was the *dupla* of the firſt; and between thoſe two, other two proportionals ſhould be found, ſo as for the fourth proportional to become the *dupla* of the firſt; it is manifeſt that the cube, which would be form'd in the ſecond proportional, would be the *dupla* of that form'd in the firſt; becauſe the cube of the firſt line would be, with regard to the ſecond, as the firſt line to the fourth; but the firſt would be to the fourth as 1 to 2; therefore the firſt cube would be to the ſecond, as 1 to 2.

Therefore for the duplication of the altar of *Delos*, which was cubical, there ſhould have been taken a line *duple* each of its ſides; and between the ſide and that line, two middle proportionals ſhould have been ſearched.

Sixth PROBLEM. A triangle given, to make a rectangular parallelogram equal to it.

Let ABC, *Fig.* 77. be the triangle given, thro' whoſe vertex A, muſt be drawn the right line AG, parallel to the baſe BC; then the baſe BC is to be divided into two equal parts in the point D, from which the perpendicular DE is drawn as far as to the parallel AG: Let EF be taken equal to the ſide DC, and the ſide CF be drawn, the rectangle DF will be equal to the triangle given.

Seventh PROBLEM. A parallelogram being given, to make a ſquare equal to it.

Let CDEF, *Fig.* 79. be the parallelogram given, between the longitude thereof DC, and its altitude CF, or C*f*, the middle proportional CA muſt be found; the ſquare CB, of that middle proportional, will be equal to the given rectangle.

Eighth PROBLEM. To meaſure an horizontal line, which can only be acceſſible by one of its extremities.

Let it be the line AB, *Fig* 89. which can only be acceſſible in the point B, the longitude of which line is to be ſearched.

Firſt, let a perpendicular be drawn in the point B, to that ſame line AB, *viz.* BC, in this manner: You muſt place the center of the inſtrument, *viz.* of the *ſemicircle*, deſcribed *Fig.* 90. in the point B, and through the holes of its immobile dioptre *d d*, *Fig* 90, 91. look at ſome fix'd object, placed in the other extremity of the line, *viz.* a ſmall tree, or the tower A, and move the dioptre, or mobile rule, till it departs from the baſe, or immobile rule. by the whole ſquare, or 90 degrees: if through the holes which are open in the *pinnulæ* of the dioptre, you look ſome mark placed in C, you'll have the right angle ABC.

Let the inſtrument be transferred into C, ſo that its center anſwers to the point C, and the holes of the immobile dioptre *d d*, be directed on the point B; turn the moveable dioptre without moving the inſtrument, till the ſign A appears thro' the moveable *pinnula e e*; then you'll know the quantity of the angle ACB in the limb *e d* of the ſemicircle.

To meaſure the line BC, you muſt draw on paper the line FE, *Fig.* 90. divided into ſo many equal parts, as there are feet found in the line BC, and let the angle FEG, *Fig.* 90. be equal to the angle BCA, afterwards the perpendicular FG muſt be drawn thro' the point F, meeting with the line EG in the point G. If with the ſcale you meaſure how many parts there are in FG equal to the parts of the line FE: I ſay that there are as many feet in AB.

Demonſtration. The triangle ABC, and GFI, are equiangles, by conſtruction; therefore as FD is to FG, ſo is BC to BA: ſo that as many aliquot parts of the line EF, are contained in FG; ſo many ſimilar aliquot parts from the line BC will be contained in BA.

Ninth PROBLEM. To meaſure an acceſſible altitude.

Make uſe, as in the preceding problem, of the ſemicircle ſo diſpoſed, that its diameter or baſe be parallel to the horizon; then riſe or lower its mo-

bile dioptre, till through its *pinnula* the vertex A, *Fig.* 91. be ſeen: afterwards look downward thro' the ſame *pinnula*, that you may have the point C; mark carefully the angle A I, or E I C equal to it, to which the angle A C B is equal likewiſe. Suppoſe it, for example, to be of 57 degrees, 25 minutes: then meaſure with the hexapedes the diſtance CB, which will be, *v. gr.* of 235 feet. If a triangle be made on paper like unto that, the altitude B A will be found to be of 367 feet, and a little more.

But this *problem* is reſolved, with a greater accuracy, by the table of the *ſines*: for if the circle be deſcribed from the point C, in the internal CB, the *radius* CB will be the whole ſine: the line CA, will be the ſecant; and the line, or tower AB, will be the tangent of the angle A C B. Therefore if it be ſaid, as the *whole ſine*, which in the table is 10000000, is to the tangent of the angle A C B, 57 degrees, 25 minutes, which is in the tables 15616590; ſo is the diſtance C B, which is found to be of 235 feet to the altitude or height B A: this altitude BA will be found by the rule of proportion to be of 367 feet eight inches.

As that part of *Geometry* which regards the ſolution of triangles, or whereby their ſides are known by the rules of proportion, and expreſſed by number, is called *Trigonometry*, I'll defer mentioning any thing about it, till I come to the letter T, where I deſign to write an entire treatiſe of that art, *Trigonometry*.

GILDING.

GILDING is the art of ſpreading or covering a thing with gold, either in *leaf* or *liquid*.

There are ſeveral *methods* of *gilding* in uſe among us, as gilding in *water*, gilding in *oil*, gilding by *fire*, &c.

Water-gilding requires more preparation than *oil-gilding*, and is chiefly on *wooden* works, and thoſe made of *ſtucco*; and theſe too muſt be ſheltered from the weather. A ſize is uſed for this way of *gilding* made of ſhreads, &c. of parchment or leather boiled in water to the conſiſtence of a jelly: if the thing to be gilt be of wood, it is firſt waſhed with this ſize, boiling hot, and then ſet to dry; and afterwards with white paint mixed up with the ſame ſize. Some uſe *Spaniſh* white for this purpoſe, and others plaſter of *Paris*, well beaten and ſifted: this ſized paint muſt be laid on with a ſtiff bruſh; which is to be repeated ſeldomer or oftener according to the nature of the work, as ten or twelve times in flat or ſmooth works, but ſeven or eight will be ſufficient in pieces of ſculpture. In the former caſe they are applied by drawing the bruſh over the work, in the latter by dabbing it. When the whole is dry, they moiſten it with fair water, and rub it over with ſeveral pieces of coarſe linen, if it be on the flat; if not, they beat or ſwitch it with ſeveral ſlips of the ſame linen, tied to a little ſtick, to make it follow and enter all the cavities and empreſſures thereof.

Having thus finiſhed the white, the next thing to be done, is to colour it with yellow ochre: but if it be a piece of ſculpture in relievo, they firſt touch it up, and prepare the ſeveral parts, which may have been diſfigured, by the ſmall iron inſtruments, as gouges, chiſſels, &c. The ochre uſed for this purpoſe muſt be well ground and ſifted, and mixed up with the ſize before-mentioned. This colour is to be laid on hot; and in works of ſculpture, ſupplies the place of gold, which ſometimes cannot be carried into all the depreſſures and cavities of the foliages and other ornaments; a lay is alſo applied over this yellow, which ſerves for the ground on which the gold is to be laid: this lay is uſually compoſed of *armenian-bole*, *blood-ſtone*, *black-lead*, and a little *ſoot*; to which ſome add *ſoap*, and *oil* of olives; others, *burnt-bread*, *biſtre*, *antimony*, *glaſs of tin*, *butter*, and *ſugar-candy*. Theſe ingredients being all ground down together with hot ſize, three lays of this compoſition is applied upon the yellow, the one after the other has been dried; being cautious not to put any into the cavity of the work to hide the yellow.

The bruſh, uſed for this purpoſe, muſt be a ſoft one; and when the matter is become very dry, they go over it again with a ſtronger bruſh, to rub it down, and take off the ſmall grains that ſtick out, in order to facilitate the burniſhing of the gold.

To be prepared for *gilding*, you muſt have three ſorts of *pencils*; one to wet, another to touch up and amend, and a third to flatten; alſo a gilding *cuſhion*, for ſpreading the leaves of gold on, when taken out of the book; a *knife* to cut them, and a *ſquirrel's-tail* fitted with a handle; or elſe a piece of fine ſoft ſtuff on a ſtick, to take them up directly and apply them.

You are firſt to begin with wetting your pencils; by which the laſt lay laid on with water is moiſtened, that it may the better receive and retain the gold. Then you are to lay the leaves of gold on

the

the cuſhion, and if whole, you muſt take it up with the ſquirrel's tail, but if in pieces, with the other inſtrument, or the knife wherewith they are cut, and lay and ſpread them gently on the parts of the work you had moiſtened before. If the leaves, as they frequently do, happen to crack or break in laying on, theſe breaches muſt be made up with ſmall bits of leaf, taken up upon the repairing pencil, and the whole work is to be ſmoothed either with the ſame pencil, or another ſomewhat larger; the gold being preſſed into the dents, into which it could not be ſo eaſily carried by the ſquirrel's tail.

The work having been thus far gilded, muſt be ſet to dry, in order to be burniſhed or flatted.

The laſt operation is the applying the *vermeil* in all the little lines and cavities; and to ſtop and amend any little faults with ſhell-gold. The compoſition called *vermeil* is made of *gum-guttæ*, *vermilion*, and a little of ſome *ruddy-brown*, ground together with *Venetian* varniſh, and oil of turpentine. Some gilders, inſtead of this, make ſhift with fine *lacca*, or *dragon's blood*, with *gum-water*.

Sometimes inſtead of burniſhing the gold, they burniſh the ground or compoſition laid on the laſt before it, and only afterwards waſh the part over with the ſize. This method is chiefly practiſed for the hands, face, and other nudities in relievo: which, by this means, do not appear ſo very brilliant as the parts burniſhed; though much more ſo than the parts perfectly flat.

To gild a piece of work, and yet preſerve white grounds, they apply a lay of *Spaniſh* white, mixed with a weak fiſh-glue on all the parts of the ground, whereon the yellow or the laſt lay might run.

GILDING in *oil* requires much leſs apparatus than that before-mentioned. The baſis or matter whereon the gold is laid, in this method, is the remains of colours found ſettled to the bottom of the pots in which painters waſh their pencils. This matter, which is very viſcid or ſticky, is firſt ground, and then paſſed through a linen-cloth, and thus laid on the matter to be gilt, after it is waſhed once or twice over with ſize; and if it be wood, with ſome white paint.

When this is almoſt dry, but yet is ſtill unctuous enough to catch and retain the gold, the leaf-gold is laid on, either whole, if the work be large, or cut to pieces, if ſmaller; the leaves of gold are taken up and laid on with a piece of fine, ſoft, well-carded cotton; or ſometimes by a palat for the purpoſe; or ſometimes with the knife with which the leaves were cut, according to the parts of the work that are to be gilded, or the breadth of the gold that is to be laid on. As the gold is laid on, they paſs over it a coarſe ſtiff pencil or bruſh, to make it ſtick and as it were incorporate with the ground; and after this they mend any cracks that may have happened in it, either with the ſame pencil or one that is ſmaller, as has been ſhewn before in *water-gilding*.

This kind of gilding is chiefly uſed for domes and roofs of churches, courts, banqueting houſes, *&c.* and for figures of plaſter of Paris, lead, *&c.*

Gilding with liquid gold is performed by gold reduced to a calx and amalgamated with *mercury*, in the proportion of about an ounce of *mercury* to a dram of *gold*. To perform this, they heat a crucible red-hot, and then put the gold and mercury into it, ſtirring them gently about till the gold be found melted, and incorporated into a maſs with the mercury. When this is done, they caſt them into water, to waſh and purify them; and out of that into other waters, where the amalgama, which is almoſt as liquid as if there were nothing but quick-ſilver in it, may be preſerved a long time for uſe.

Before they proceed to lay this amalgamated gold on the metal, they firſt render the metal rough, by waſhing it over with *aqua-fortis*, or *aqua ſecunda*; and afterwards rinſe the metal in fair water, and ſcour it a little with fine ſand, and then it is ready for the gold.

They next cover over the metal with the mixture of *gold* and *mercury*, taking it up with a ſlip of *copper*, or a bruſh made of braſs-wire, ſpreading it as even as poſſible; to do which they wet the bruſh from time to time in fair water. Then they ſet the metal to the fire, upon a grate, or in a ſort of cage, under which ſtands a pan of coals; and in proportion as the mercury, evaporating and flying off, diſcovers the places where gold is wanting, they take care to ſupply them by adding new parcels of amalgama.

Then the work is rubbed over with the wire-bruſh, dipt in beer or vinegar, which leaves it in a condition to be brought to a colour, which is the laſt part of the proceſs, and which the gilders keep to themſelves as a mighty ſecret.

To gild by fire on metal. To prepare the metal, they ſcratch it well, or rake it; then poliſh it with a poliſher; and afterwards ſet it to the fire to blue, *i. e.* to heat, till it appears of a blue colour. When this has been done, they clap on the firſt lay of leaf-gold, rubbing it lightly down with a poliſher; and expoſe it thus to a gentle fire. They uſually give it but three ſuch lays, or four at the moſt, each lay conſiſting of a ſingle leaf for common works, and of two for extraordinary ones: after each lay, it is ſet a-freſh to the fire; and after the laſt lay, the gold is in condition to be burniſhed.

To gild paper, grind *bole-armeniac* with rain-water, and give one laying of it; when it is dry, take

take glair of eggs, and add to it a little ſugar-candy and gum-water, which lay over the former, and upon this, when it is dry enough, lay leaf-ſilver, or leaf-gold.

To gild the leaves of books, take *bole-armoniac*, eight penny-weight; ſugar-candy, two penny-weight: mix and grind them with glair of eggs: then on a bound book (while it is in the preſs, after it hath been ſmeared with glair of eggs, and is dried) ſmear the ſaid compoſition, let it dry, then rub it well and poliſh it; then with fair water wet the edges of the book, and ſuddenly lay on the gold, preſs it down gently with cotton: let it dry, and then poliſh it with a tooth.

GLASS.

GLASS (from the *Latin* word *glaſtum*) ſeems to take its name from its colour, which is naturally *azure* or ſky colour; or from its reſemblance to *glacies* or ice, or from its tranſparency.

It is a tranſparent, brittle, factitious body or metal produced by the action of fire; and it is the laſt effect of fire, as all its force is not able to carry the change of any natural body beyond its vitrification.

The origin of this metal can't be quite aſcertain'd, for ſome authors carry its invention as high as the antediluvian age, and patronize it with the name of *Tubal Cain*, the ſon of *Lamech*; becauſe ſay they, it is ſcarce poſſible to calcine metals, without reducing them into *glaſs*; and it is allowed that *Tubal* was the firſt that found out the art of melting metals. See Gen. iv.

Others rather choſe to find its origin amongſt the *Brick-makers*, employed in the building of *Babel*; imagining it impoſſible to burn clay after their manner, without meeting with vitrification, or ſome part thereof run into *glaſs*. However this may be, it is certain that *glaſs* is mention'd in the Bible, not very diſtant from that epocha.

The great *Hermes*, father of philoſophers, was poſſeſſed of this art of *making glaſs*. And *Lucretius*, lib. iv. gives us another evidence of the greater antiquity of this invention.

Pliny, pretends to fix its invention in the city of *Sidon*, where he affirms the firſt *glaſs veſſels* were made, lib. 26. cap. 26. and ſpeaking of this art in another place, lib. 5. cap. 19. he allows, that we are indebted to chance for its invention, which was on the banks of the river *Belus*, in *Syria*, where certain merchants drove aſhore, diſcover'd that the herb *Kali* on that coaſt being reduced to aſhes by the fires they made to dreſs proviſions, and mixing it with ſand and ſtones, became a ſort of melted glaſs. See alſo *Joſephus's wars of the Jews*, lib. ii. cap. 9. 17. which in a great meaſure confirms this account.

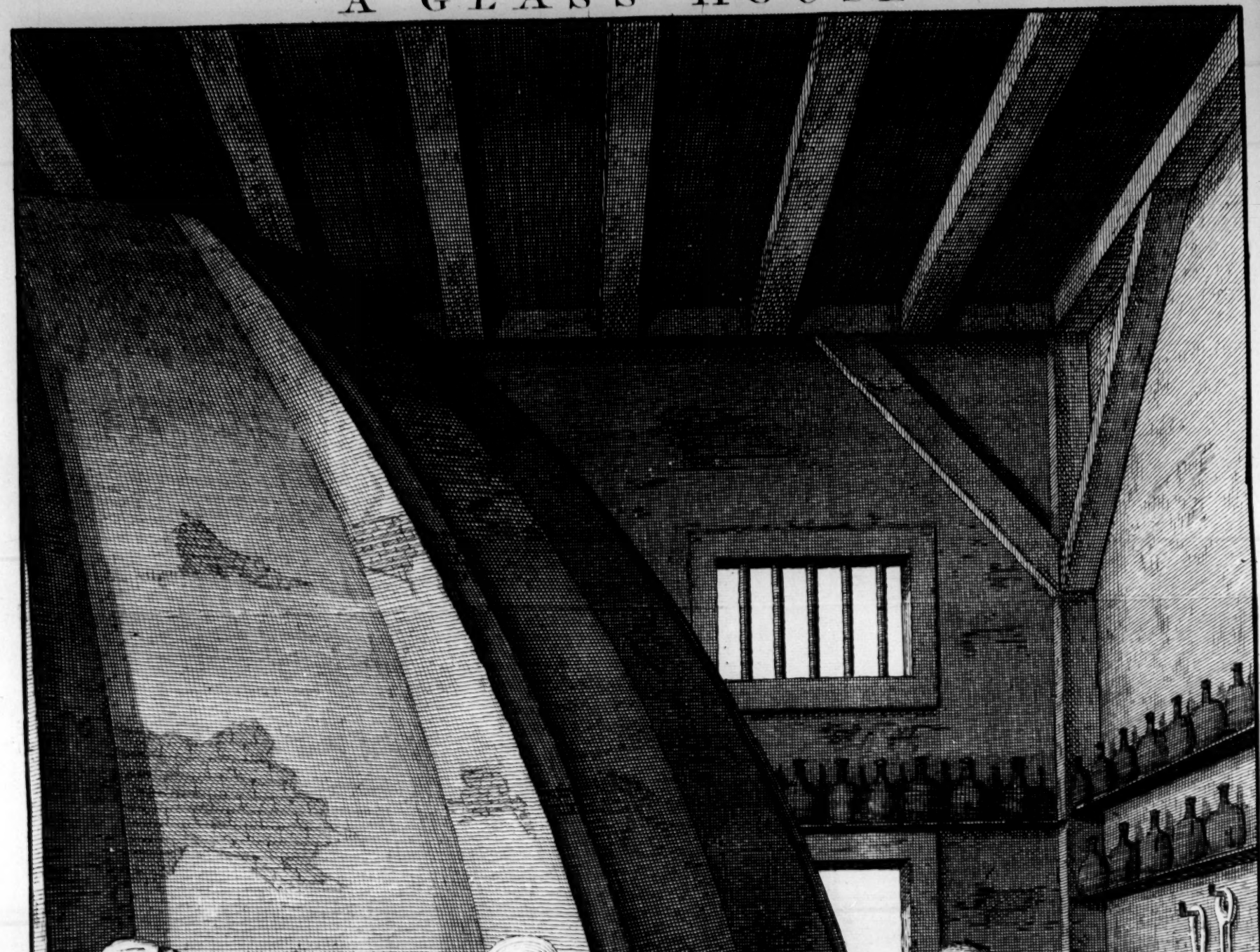
Venice for many years excelled all *Europe* in the manufacture of glaſs. But *England* now ſurpaſſes all the world, in all the different branches of this manufacture.

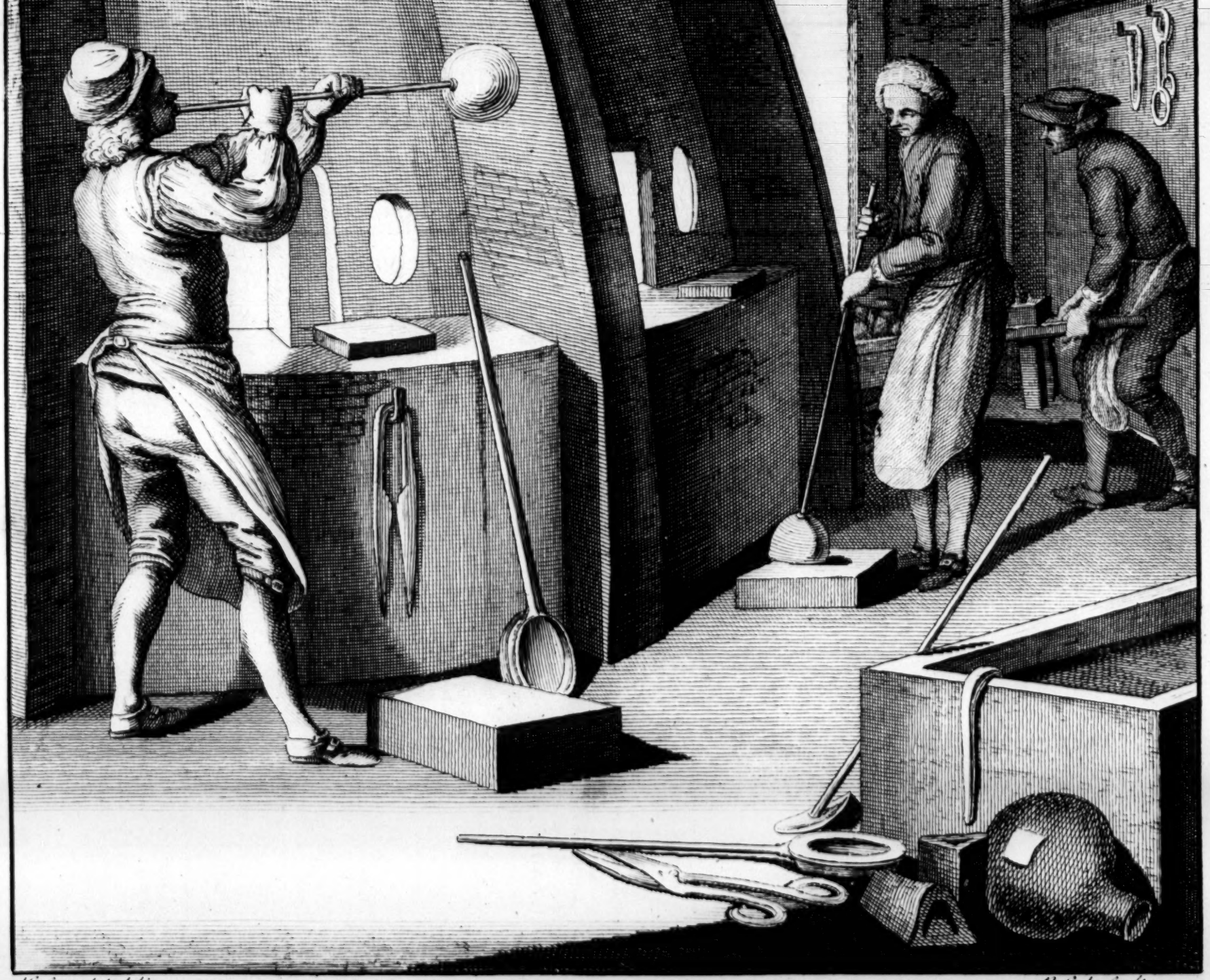
The ſeveral *characters* and *properties* of Glass whereby it is diſtinguiſhed from all other bodies, are thus enumerated by our learned countryman Dr. Merret.

1. It is an artificial concrete of ſalt and ſand, or ſtone. 2. Fuſible by ſtrong fire. 3. When fuſed, tenacious and coherent. 4. It does not waſte nor conſume in the fire. 5. When melted, it cleaves to iron. 6. When it is red hot, it is ductile, and may be faſhioned into any form; but not malleable; and capable of being blown into a hollowneſs, which no mineral is. 7. Frangible, when thin, without annealing. 8. Friable, when cold. 9. Diaphanous, whether hot or cold. 10. Flexible and elaſtic. 11. Diſſoluble by cold and moiſture. 12. Only capable of being graven or cut with a diamond, or other hard ſtone, and emery. 13. Receives any dye or colour both externally and internally. 14. Not diſſoluble by aqua fortis, aqua regia, or mercury. 15. Neither acid juices nor any other matter extract either colour, taſte, or any other quality from it. 16. Admits of poliſhing. 17. Neither loſes weight nor ſubſtance by the longeſt and moſt frequent uſe. 18. Gives fuſion to other metals, and ſoftens them. 19. The moſt pliable thing in the world, and that which beſt retains the faſhion given it. 20. Not capable of being calcined. 21. An open glaſs being filled with water in the ſummer-time, will gather drops of water on the outſide, juſt ſo far as the water on the inſide reaches; and a perſon's breath blown on it will manifeſtly moiſten it. 22. Little glaſs balls filled with water, mercury, and other liquor, and thrown into the fire; as alſo drops of green glaſs being broken, will fly aſunder with a great noiſe. 23. Neither wine, beer, nor any other liquor, will make it muſty, or change its colour, or ruſt it. 24. It may be cemented, as ſtones and metals. 25. A drinking-glaſs, partly filled with water, and rubbed on the brim with a wet finger, yields muſical notes, higher or lower as the glaſs is more or leſs full, and will make the liquor friſk and leap.

The

A GLASS HOUSE





M. Gravelot delin.

B. Cole fculp.

The materials whereof *glaſs* is made, are ſalt and ſand, or ſtones. The ſalt here uſed, is procured from a ſort of aſhes, brought from the *Levant*, called *polverine*, or *rochetta*; which aſhes are thoſe of a ſort of water-plant, called *kali*, cut down in ſummer, dried in the ſun, and burnt in heaps, either on the ground, or on iron grates; the aſhes falling into a pit, grow into a hard maſs, or ſtone, fit for uſe.

To extract the ſalt, theſe aſhes, or *polverine*, are powdered and ſifted, then put into boiling water, and there kept till one-third of the water be conſumed; the whole being ſtirred up, from time to time, that the aſhes may incorporate with the fluid, and all its ſalts be extracted: then the veſſel is filled up with new water, and boiled over again, till one-half be conſumed; what remains is a ſort of lee, ſtrongly impregnated with ſalt. This lee, boiled over again in freſh coppers, thickens in about twenty-four hours, and ſhoots its ſalt; which is to be laded out, as it ſhoots, into earthen pans, and thence into wooden fats to drain and dry. This done, it is groſsly pounded, and thus put in a ſort of oven, called calcar, to dry.

It may be added, that there are other plants, beſides *kali*, which yield a ſalt fit for *glaſs*: ſuch are the *alga* or *ſea-weed*, the *common way-thiſtle*, *bramble*, *hops*, *wormwood*, *woad*, *tobacco*, *fern*, and the whole leguminous tribe, as *peaſe*, *beans*, &c.

The ſand or ſtone, called by the artiſts *tarſo*, is the ſecond ingredient in *glaſs*, and that which gives it the body and firmneſs. Theſe ſtones, *Agricola* obſerves, muſt be ſuch as will fuſe; and of theſe, ſuch as are white and tranſparent are beſt; ſo that *cryſtal* challenges the precedency of all others.

At *Venice* they chiefly uſe a ſort of pebble, found in the river *Teſino*, reſembling white marble, and called *cuogolo*. *Ant. Neri* aſſures us, that all ſtones, which will ſtrike fire with ſteel, are fit to vitrify: but Dr. *Merret* ſhews, that there are ſome exceptions from this rule. *Flints* are admirable; and when calcined, powdered, and ſearched, make a pure white cryſtalline metal. Where proper ſtones cannot be ſo conveniently had, *ſand* is uſed; which ſhould be white, and ſmall, and well waſhed, before it be applied: ſuch is uſually found in the mouths and ſides of rivers. Our *glaſs-houſes* are furniſhed with a fine ſand for cryſtal, from *Maidſtone* and *Yarmouth*, the ſame with that uſed for ſand-boxes, and in ſcouring; and with a coarſer for *green-glaſs* from *Woolwich*.

For *cryſtal-glaſs*, to 200 lb. of *tarſo*, pounded fine, they put 130lb. of ſalt of *polverine*; mix them together, and put them into the *calcar*, a ſort of reverberatory furnace, being firſt well heated. Here they remain baking frying, and calcining, for five hours, during which the workmen keeps mixing them with a rake, to make them incorporate: when taken out, the mixture is called *frit*, or *bollito*.

Glaſs might be made by immediately melting the materials without thus calcining, and making them *frit*: but the operation would be much more tedious.

A *glaſs* much harder than any prepared in the common way may be made by means of *borax*, in the following manner. Take four ounces of *borax*, and an ounce of fine *white ſand*, reduced to powder, and melt them together in a large cloſe crucible, ſet in a wind furnace, keeping a ſtrong fire for half an hour: then take out the crucible, and when cold, break it; and there will be found at the bottom a hard, pure glaſs, capable of cutting common glaſs almoſt like a diamond. This experiment duly varied, ſays Dr. *Shaw*, may lead to ſome conſiderable improvements in the *art of glaſs*, *enamels*, and *artificial gems*. It ſhews us an expeditious method of making *glaſs* without the uſe of fixed ſalts, which has generally been thought an eſſential ingredient in *glaſs*, and which is the ingredient that gives common glaſs its ſoftneſs; and it is not yet known, whether calcined cryſtal, or other ſubſtances, being added to this ſalt, inſtead of ſand, might not make a glaſs approaching to the nature of a diamond.

Next to the materials or *ingredients* of which *glaſs* is made, it is neceſſary to ſubjoin an account of the *furnaces* and *inſtruments* required for the work.

A GLASS-MAKER muſt be furniſhed with FURNACES; *viz.* with one to prepare the *frit*, called the *calcar*; a ſecond to *work* the *glaſs*; and a third called the *leer*, to *anneal* it.

The firſt furnace, called the *calcar*, is made in faſhion of an oven, ten foot long, ſeven broad, and two deep. The fuel is ſeacoal and wood, and is put in a trench, on one ſide of the furnace: the flame reverberates from the roof back upon the *frit*, in order to calcine it.

The ſecond is the working furnace, ſerving to melt the metal in, or make the *glaſs*; its figure is round, three yards in diameter, and two high, being arched over. Round the inſide, are eight or more pots placed, and piling pots on theſe. The number of pots ſhould be double that of the bocca's or mouths, or that of the workmen; that each may have one pot refin'd, to work out of, and another for metal to refine in, while he works out of the former.

The furnace has two partitions, the lower, ſeparating the pots from the fire-place, has a circular hole in the center, covered with a grate, through which the flame paſſes from the fire-place into the

furnace,

furnace; from the arched ſides and roofs whereof it is reverberated into the melting pots. The ſecond partition divides this from the *leer*, or *annealing furnace*. Through the bocca's or working holes, the metal is taken out of the pots, and the pots put in the *furnace*. Theſe bocca's are ſtopp'd with moveable covers, made of lute and brick, to ſkreen the workmen's eyes from the fire. On each ſide the bocca is a boccarella, out of which coloured *glaſs*, or the finer metal, is taken from the piling pots to the furnace; likewiſe ovens, or holes near the leer, for the calcining of tartar, iron, *&c.*

The *leer*, which ſerves to anneal and cool the veſſels, and which *Agricola* makes a particular *furnace*, conſiſts of a tower beſides the leer. The tower lies directly over the melting *furnace*, with a partition betwixt them a foot thick; having an aperture called *Occhio* or *Lumella*, through which the flame or heat aſcends out of the *furnace* into the tower: on the floor, or bottom of this tower, the veſſels faſhioned by the maſters are ſet to anneal. It has alſo two bocca's, or mouths, by which the *glaſſes* are put in with a fork, and ſet on the floor.

The *leer*, is an avenue five or ſix yards long, continued to the tower: through this the *glaſſes*, when annealed, are drawn in iron pans called *fraſhes*; by which they come to cool by degrees: being quite cold by that time they reach the mouth of the *leer*, which enters the *faroſel*, or room where the *glaſſes* are to be ſet.

The third is the *green glaſs furnace*, which is a kind of compound of all the former. It is made ſquare (the two former being circular) having an arch at each angle thereof, for annealing and cooling the glaſſes. The metal is wrought on two oppoſite ſides; and on the other two they have their *calcars*, into which are made linnet holes, for the fire to come from the *furnace* to bake the *frit*, and alſo to diſcharge the ſmoak. Fires are made in the arches to *anneal* the veſſels, ſo that the whole proceſs is done in one *furnace*.

The *inſtruments* made uſe of in this work, may be reduced to theſe that follow. A blowing pipe, made of iron, about two feet and a half long, with a wooden handle. An iron rod to take up the glaſs, after it is blown, and to cut off the former. Sciſſars to cut the glaſs when it comes off from the firſt hollow iron. Shears to cut and ſhape great glaſſes, *&c.* an iron ladle, with the end of the handle caſed with wood, to take the metal out of the refining pot, to put it into the workmens pots. A ſmall iron ladle, caſed in the ſame manner, to ſkim the alkalic ſalt, that ſwims at top. Shovels, one like a peel to take up the great glaſſes; another, like a fire ſhovel, to feed the furnace with coals. A hooked iron fork, to ſtir the matter in the pots. An iron rake for the ſame purpoſe, and to ſtir the *frit*. An iron fork, to change or pull the pots out of the furnace, *&c.*

By theſe means there may be made many ſorts of *glaſs*; the principal of which, in uſe, are, 1. The *cryſtal flint glaſs*. 2. The *cryſtal white glaſs*. 3. *Normandy* or *Crown glaſs*. 4. *Green-window*, or *Newcaſtle glaſs*, and 5. *Bottle glaſs*.

Of the *firſt* ſort is made *plate glaſs*, for *coaches*, *mirrors*, *teleſcopes*, &c. Of the *ſecond* ſort, all kind of drinking glaſſes, decanters, mugs, cups, *&c.* for the table; toys, phials, *&c.* Of the *third* ſort is made the beſt *glazing* for windows, and pictures. Of the *fourth* ſort is made the ordinary glazing for windows: and the *fifth* ſort ſerves for nothing but bottles, for beer and other liquors in the cellar.

We'll begin the operation with *cryſtal* and *white glaſs*. To prepare the matter for making *white* and *cryſtal glaſs*, which muſt be of the whiteſt *tarſo*, (pounded ſmall, and ſifted as fine as flour) two hundred pounds, and an hundred and thirty pounds of the ſalt of *polverine*: theſe are mixed together, and put into the furnace, call'd *calcar*, firſt heating it; for an hour keeping a moderate fire, and ſtirring continually the materials, that they may incorporate, and calcine together: then increaſing the fire for five hours; after which the matter muſt be taken out, which, being now ſufficiently calcined, is called *frit*; and which from the *calcar*, is to be put in a dry place, and covered up from the duſt, for three or four months.

The *glaſs*, or *cryſtal*, is made, by taking of this *frit*, called alſo *bollito*, and ſetting it in pots, in the furnace; adding to it a due quantity of *manganeſe*: when the two are fuſed, the *fluor* is caſt into fair water, to clear it of the ſalt, call'd *ſandever*, which, otherwiſe, would make the cryſtal obſcure, and cloudy. This lotion muſt be repeated again, and again, as often as needful, till the cryſtal be fully purged. Then it muſt be ſet to boil four, five, or ſix days; which done, it muſt be ſeen if it has *manganeſe* enough; if not, and it be *greeniſh* yet, more *manganeſe* is to be added to it at diſcretion, by little and little at a time; taking care not to overdoſe it, by reaſon the *manganeſe* inclines it to a *blackiſh hue*. Then the metal is ſet to clarify, till it becomes of a clear and ſhining colour; which done, it is fit to be blown, or formed into veſſels, at pleaſure.

Our materials thus prepared, we'll begin the operation, by *blowing round glaſſes*, and preſuppoſing that our *furnace* is heated as it ſhould be, and the matter

matter in the two of the ſix pots, placed in it, ſufficiently vitrified, we'll take our *blowing iron*, and dipping it in one of theſe two pots, turn it about in it; the metal will ſtick to the iron like a glutinous, or clammy juice, much like turpentine.

For each *glaſs* we'll dip it four times, and at each dip roll the end of our blowing iron, with the *glaſs* thereon, on a piece of iron, over which is a veſſel of water, the coolneſs whereof helps to conſolidate the *glaſs* more readily, and diſpoſes it the better to bind with the next to be taken out of the pot.

After we have dipped a fourth time, and there is now matter enough on the inſtrument, we begin to blow gently thro' the iron; by which we riſe, according to the nature of the work, the ſame as we do by blowing in a bladder; and to give it a poliſh, we roll it to and fro on a ſtone, or marble. This done, we blow a ſecond time, and thus form the bunch, or belly of the *glaſs*, the matter, by this ſecond blaſt, aſſumes the figure of a gourd.

As often as we blow into the iron we muſt remove it haſtily from our mouth to our cheek, leſt we ſhould draw the flame into our mouth, when we re-apply it to the iron.——We muſt whirl our iron-rod many times round our head, to lengthen and cool the glaſs; ſometimes the *glaſs*, thus blown round, is returned to the fire, where it flattens a little of itſelf; when flatten'd, it is taken out, and cool'd; and, if needful for the deſign, we muſt flat its bottom, by preſſing it on the marble, or mould it in the ſtamp-iron, and thus deliver it to the maſter-workman to break off the *collet*; which *collet* is the narrow part, which clave to the iron.

To ſet the *glaſs* at liberty, he muſt lay a drop of cold water on the *collet*; which by its coldneſs will cut, or crack about a quarter of an inch: after which giving it a ſlight blow, the fracture is communicated all around the *collet*.

This done, we dip an iron-rod, or *ponteglo*, in the melting pots, and with the matter that ſticks thereto, we'll apply and faſten it to the bottom of the veſſel, oppoſite to the *collet*.—The veſſel thus ſuſtained by the iron-rod, is carried to the great *bocca* to be heated, and ſcalded; and while another perſon takes care thereof, the former operator reſts, and prepares himſelf for the branching, or making the bowl, which is done by thruſting in an iron inſtrument, called *paſſago*, whereby the aperture is opened, and afterwards augmented further, and widened with the *procello*: in turning this inſtrument about, to form the bowl, the edge becomes thickned; the *glaſs* being, as it were, doubled in that part; whence the hem obſerved on the circumference of our *glaſſes*. What is ſuperfluous, is cut off with the ſhears.

The veſſel thus opened is returned to the great *bocca*, where being ſufficiently heated a ſecond time, the workman gives the bowl its finiſhing, by turning it about with a circular motion; which it increaſes in proportion as the bowl opens, and enlarges by means of the heat and agitation.

The *glaſs* thus finiſhed, they carry it from the *bocca* ſtill turning it round, to a kind of earthen bench covered with brands, or coals extinguiſhed: here they let it cool a little, and come to its conſiſtence; having firſt detached it from the iron-rod, by a ſtroke or two with the hand. Thus with blowing, ſcalding, amplifying, and cutting, the glaſs is framed into the ſhape, preconceived in the workman's mind. If need be he proceeds to put on a foot and handle, and with the *ſpiei* puts on rigarines and marblings.

When the maſter has finiſhed a number of them, a ſervitor takes them with an iron-fork, and ſpeedily places them in the tower or *leer*, to *anneal* and harden.

Annealing, or *nealing* of *glaſs*, is the baking of *glaſs* to dry, harden, and give it the due conſiſtence, after it has been blown and faſhioned in the proper works. *Nealing* is alſo uſed in the art of ſtaining *glaſs* with metal colours.

What has been here ſaid, of *white* or *cryſtal glaſs*, holds equally of *common* or *green glaſs*, the working being the ſame in all, and the difference only in the ſalt or *polverine*.

So many maſters as there are, ſo many pots at leaſt, and ſo many *bocca*'s there muſt be; each man having his proper ſtation. They ſit in large wide wooden chairs, with two long elbows, to which their inſtruments are hung. They work ſix hours at a time, meaſured by a ſingle glaſs; after which they are relieved by others for the like time, ſo that the furnaces are never idle.

From *round*, *cryſtal*, and *white glaſſes*, we'll paſs to the blowing *crown*, *Normandy* or *table-glaſſes*: for which operation the *furnace*, *melting-pots*, *materials*, and *fire*, are nearly the ſame as for *round-glaſs*; and the difference only commences after the operator has dipped his *blowing-iron* the fourth time in the melted metal. The *glaſs* then being in this condition, they blow it; but inſtead of rounding, or forming it into a bunch, the particular motion the workmen gives it in the directing and managing the wind, and the way of rolling it on the iron, makes it extend in length 16 or 20 inches, and form a cylinder, which being recommitted to the fire, and blown afreſh, when taken out, becomes of the extent required for the table of *glaſs* to be formed.

Then the *blower* preſents it to the *flaſher*, or the *maſter glaſs-maker*, who, being ready with a *pointil*, *i. e.* an iron-rod tipt with a ſmall quantity of hot metal, claps it cloſe to the center of the bot-

tom of the round ball of metal thus blown: which immediately uniting or cementing together, the *collet* is broke by the blower, and the maſter takes away the ball of metal, and preſents it to the mouth of the flaſhing furnace, whoſe flames ſallying forth at a large mouth, and entering into the metal preſented by the hole made in the *collet*, enlarges the aperture, till it at laſt brings the globular metal into a circular plane of an equal thickneſs, excepting where a nob is made in the center by the tool that holds it: the maſter, with great dexterity, all the time keeping it twirling round in the flame, upon an iron prop before the mouth of this furnace. This performed, the table is ſtruck off in the ſame manner as directed in the cutting of the *collet*; and delivered to the proper perſon to place it in the *leer*, to *anneal*, or temper.

The proceſs for *green glaſs* for *windows* is nearly the ſame; only that when the *green glaſs* is blown to its proper extent, it is ſmaller at the end faſtened to the iron, than at the other extremity; being blown cylindrical or long: ſo that to render the two ends nearly of the ſame diameter, after adding a little *glaſs* to that oppoſite to the iron, they draw it out with a pair of iron pincers; then they cut off the ſame end with a little water; and carrying the cylinder back to the *bocca*, they cut it likewiſe with water in two other places, one eight or ten inches from the iron, and the other the whole length.

The *glaſs* cylinder thus abridged of both its extremities, is next heated on a kind of earthen table, ſomewhat raiſed in the middle, in order to promote its opening at the place incided longitudinally. The workman here makes uſe of an iron, wherewith he alternately lowers and raiſes the two ſides, or halves of the cylinder, which now begin to open and unfold like a ſheet of paper, and at length grow perfectly flat. The table of *glaſs* is now in its laſt perfection, and needs nothing further but to be heated over again: when taken out they lay it on a table of copper; when, after it has cooled and come to its conſiſtence, they carry it on forks to the tower of the furnace, where they leave it to *anneal* for twenty four hours. See the *Plate* of a GLASS-HOUSE.

The laſt, and moſt curious operation perform'd in a *glaſs-houſe*, is that of *blowing*, and *caſting* LOOKING-GLASS PLATES; which, tho' made of much the ſame materials as other *glaſſes*, *viz.* of alkali ſalt and ſand; it muſt, however, be obſerved, that the *ſalt* ſhould not be that extracted from polverine, or the aſhes of the *Syrian* kali, but that from *barillia*, or the aſhes of a plant of that name, of the genus of kalies, but growing about *Alicant* in *Spain*. This *barillia* is ſeldom to be got pure; the *Spaniards*, in burning the herb, making a practice of mixing another herb along with it, which alters its quality, or of adding ſand to it, to increaſe the weight; which is eaſily diſcovered, if the addition be only made after the boiling of the aſhes; but next to impoſſible, if made in the boiling: it is from this adulteration, that thoſe threads, and other defects in *plate-glaſs* ariſe.

To prepare the *ſalt*, it muſt be well purged of all foreign matters; pounded, or ground with a kind of mill, and ſifted pretty fine.

The *ſand* is to be ſifted, and waſhed, till ſuch time as the water comes off very clear; and when it is well dried again, it is to be mixed with the ſalt, paſſing the mixture through another ſieve. This done, they are laid in the annealing furnace for about two hours; in which time the matter becomes very light and white, and in which ſtate they are called *frit*, and are to be laid up in a dry clean place, to give them time to incorporate, for at leaſt a year.

When this *frit* is to be employed, it muſt be laid for ſome hours in the furnace; adding to ſome the fragments, or ſhards, of old *glaſs*; taking care, firſt, to calcine the ſhards, by heating them red-hot in the furnace, and caſting them into cold water: to the mixture muſt likewiſe be added *manganeſe*, to promote the fuſion, and purification. The matter thus prepared, is equally fit for *plate glaſs*, to be formed by *blowing*, or by *caſting*.

The furnaces for melting the materials of this manufacture, are of enormous ſize; and thoſe for annealing the *glaſſes*, when formed, much more ſo. Round a melting furnace there are, at leaſt, twenty-four annealing furnaces or ovens, each from twenty to twenty five foot long: they are called *carquaſſes*, each *carquaſſe* has two *tiſſarts*, or apertures, to put in wood, and two chimneys. Add, that beſides the annealing furnaces, *&c.* there are others for the making of *frit* and calcining old *glaſs*.

As *looking-glaſs* PLATES are made in two different manners, *viz.* by *blowing*, and by *caſting*; we'll begin with the moſt eaſy manner, which is that of *blowing*; and which is performed thus:—The materials to be blown, are fuſed in melting-pots, thirty-eight inches in diameter, and thirty-five feet high. After thoſe materials are vitrified by the heat of the fire, and the *glaſs* is ſufficiently refined, the maſter-workman dips in his blowing iron once and again, till he has got matter enough thereon.—This done, he mounts on a kind of block, or ſtool five feet high, to be more at liberty to balance it, as it lengthens in the blowing. If the work be too heavy for the workmen to ſuſtain on his blowing iron, two or more attendants aſſiſt him, by holding pieces of wood under the *glaſs*, in proportion as it ſtretches, for fear it ſhould fall off the iron by its own weight.

When after ſeveral repeated heatings and blowings, the *glaſs* is at length brought to the compaſs proper for its thickneſs, and the quantity of metal taken out; they cut it off with *forceps*, at the extremity

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The several Methods of blowing and casting Plate Glass, with the Men at Work.

tremity oppoſite to the iron, in order to point it with the *pointil*, which is a long firm piece of iron, having a piece going acroſs one of its ends in manner of a T. To point the *glaſs* they plunge the head of the T into the melting pot, and with the liquid *glaſs* ſticking thereto, they faſten it to the extremity of the *glaſs* before cut off. When it is ſufficiently faſtened, they ſeparate the other extremity of the *glaſs* from the blowing iron, and inſtead thereof make uſe of the pointil to carry it to the furnaces apointed for that end; where by ſeveral heatings they continue to enlarge it, till it be equally thick in every part.

This done, they cut it open with the forceps; not only on the ſides, by which it ſtuck to the blowing iron, but likewiſe the whole length of the cylinder: after which, giving it a ſufficient heating, it is in a condition to be entirely open'd, extended, and flatten'd: the manner of doing which is much the ſame as for *table glaſs*. Laſtly, the *glaſs* being ſufficiently flatted, is laid to anneal for ten, or fifteen days, according to the ſize and thickneſs.

See the COPPER-PLATES, B is the blowing-furnace; C the metal taken out of the pot; D a glaſs-blower; E the flaſher enlarging and opening the *glaſs*, as mentioned in the *crown glaſs*; F is the block to ſupport the man.

Looking-glaſſes thus *blown*, ſhould never be above forty-five, or at moſt fifty inches long, and of a breadth proportionable. Thoſe exceeding theſe dimenſions, cannot have the thickneſs ſufficient to bear the grinding; and, beſide, are ſubject to warp, which prevent them from regularly reflecting objects.

The next operation, the moſt curious and moſt valuable, it that of *running*, or *caſting* large *looking-glaſs plates*.

The utenſils of the *glaſs-houſes* for this operation, conſiſts in *melting-pots* as big as hogſheads, and capable to contain above two thouſand weight of metal; in *ciſterns*, which ſerve for the conveyance of the liquid glaſs, which is drawn out of the pots to the caſting tables; of a *table* made of pot-metal, about nine feet long, and broad in proportion, whereon the *glaſs* is to be run; of *iron-rulers* or *reins*, &c.

The firſt thing to be done in this operation, as in all others of this kind, is to heat the furnace red-hot.

When the furnace is red-hot, the pots are filled with materials at three different times, to facilitate the fuſion. When the matter is ſufficiently vitrified, refined, and ſettled, which uſually happens in twenty-four hours; the *ciſterns* are filled, which are in the ſame furnace, and which are left there about ſix hours longer, till ſuch time as they appear all white, through the exceſſive heat. See the *Plate* for *caſting* and *running*. PLATE-GLASS.

To get the *ciſtern* K with the metal out of the furnace G, they make uſe of a large iron chain, which opens and ſhuts with hooks and eyes; from the middle whereof, on each ſide, ariſe two maſſive iron pins, whereby, with the aſſiſtance of pullies I, the ciſtern is raiſed upon a kind of carriage of a proper height, and thus conducted to the place where the *glaſs* is to be run: here ſlipping off the bottom of the ciſtern, there ruſhes out a torrent of matter O, all on fire, wherewith the table M, prepared for that purpoſe is preſently covered. This *table* is ſupported on a wooden frame, with truſtles, for the convenience of removing from one *carquaſſe*, or annealing furnace, to another; in proportion as they are filled. ——To form the thickneſs of a *glaſs*, there are two *iron rulers*, or *reins*, NN, placed around the edge of the table; and on theſe reſt the two extremes of a kind of roller L Q, which ſerves to drive the liquid matter before it, to the end of the table, or mould. The iron rulers being moveable, and capable of being ſet cloſer, or further apart, at pleaſure, determine the width of the *glaſſes*, and retain the matter, that it does not run off at the edges. P P are the glaſs-makers, R the labourer, H the mouth of the furnace, and A is a man breaking *frit* for uſe.

As ſoon as the matter is arrived at the end of the table, and the *glaſs* is come to a conſiſtence, which is in about a minute, they ſhove it off into the annealing furnace, where it ſlides with eaſe enough, by reaſon of the ſand ſtrewed thereon.

As faſt as the ciſterns are emptied, they carry them back to the furnace, and take freſh ones, which they empty as before: this they continue to do, as long as there are any full ciſterns; laying as many plates in each *carquaſſe* as it will hold, and ſtopping them up as ſoon as they are full; to let them anneal, and cool again, which requires at leaſt ten days.

The firſt running being diſpatched, they prepare another, by filling the ciſterns anew, from the matter in the pots; and after the ſecond a third, and even a fourth time, till the melting pots are quite empty.—The ciſterns, at each running, ſhould remain, at leaſt, ſix hours in the furnace to whiten; and when the firſt annealing furnace is full, the *caſting-table* is to be carried to another.

The *glaſs*, when taken out of the annealing furnace, needs nothing further than to be ground, poliſhed, and foliated.

Glaſs thus manufactured is ſubject to ſeveral operations. It is *ground* and *poliſhed* to give it luſtre.

In order to grind *plate-glaſs*, they lay it horizontally upon a flat ſtone table, made of a very fine grained free-ſtone; and for its greater ſecurity they plaſter it down with lime, or ſtucco; for otherwiſe the force of the workmen, or the motion of the wheel, with which they grind it, would move it about.

This ſtone-table is ſupported by a ſtrong frame, made of wood, with a ledge quite round its edges, riſing about two inches higher than the glaſs. Upon this glaſs to be ground, is laid another rough glaſs not above half ſo big, and ſo looſe as to ſlide upon it; but cemented to a wooden plank, to guard it from the injury it muſt otherwiſe receive from the ſcraping of the wheel, to which this plank is faſtened; and from the weights laid upon it, to promote the grinding, or friture, of the glaſſes. The whole is covered with a wheel, made of hard light wood, about ſix inches in diameter; by pulling of which backwards and forwards alternately, and ſometimes turning it round, the workmen who always ſtand oppoſite to each other, produce a conſtant attrition between the two glaſſes, and bring them to what degree of ſmoothneſs they pleaſe by firſt pouring in water and courſe ſand: after that a finer ſort of ſand as the work advanceth, till at laſt they muſt pour in the powder of ſmalt. As the upper or incumbent glaſs poliſhes, and grows ſmoother, it muſt be taken away, and another from time to time put in its place.

This engine is called a *mill* by the artiſts, and is uſed only in the largeſt ſize glaſſes; for in the grinding of the leſſer glaſſes, they are content to work without a wheel, and to have only four wooden handles faſtened to the four corners of the ſtone, which loads the upper plank, by which they work it about.

When the grinder has done his part, who finds it very difficult to bring the glaſs to an exact plainneſs, it is turned over to the care of the poliſher, who with the fine powder of tripoli-ſtone, or emery, brings it to a perfect evenneſs and luſtre. The inſtrument made uſe of in this branch, is a board, furniſhed with a felt, and a ſmall roller, which the workman moves by means of a double handle at both ends. The artiſt in working this roller, is aſſiſted with a wooden hoop, or ſpring, to the end of which it is fixed: for the ſpring, by conſtantly bringing the roller back to the ſame points, facilitates the action of the workman's arm.

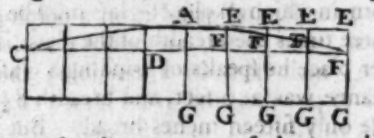
This operation only makes a plane; but our artiſts are now arrived at ſuch a perfection in *grinding of glaſs*, that they can cut or grind it into a variety of forms, in the ſame manner as diamonds are cut by a wheel. The cutting wheel is made of ſtone; which, with the help of ſand and water, makes the impreſſion: and when the glaſs is cut into the form intended, it is delivered to the poliſher, who with emery, and a leaden or wooden wheel, gives every part its luſtre. As we ſee in *ſmelling bottles*, *table-crewits*, and other houſhold *glaſs* furniture.

The moſt admirable operation in the grinding way, is the grinding of *optic glaſſes*; which is thus directed to be performed by Mr. *Huygens*. Make, ſays he, the breadth of the concave tool, plate, diſh, or form in which an object-glaſs muſt be ground, almoſt three times the breadth of the glaſs. Though in another place he ſpeaks of grinding a glaſs whoſe focal diſtance was 200 feet, and breadth 8¼ inches, in a plate only fifteen inches broad. But for eye-glaſſes, and others of leſſer ſpheres, the tools muſt be broader in proportion to the breadth of theſe glaſſes, to afford room enough for the motion of the hand in poliſhing. Mr. *Huygens* made his tools of copper, or of caſt braſs, which, for fear they ſhould change their figure by bending, can hardly be caſt too thick: however, he found by experience, that a tool fourteen inches broad, and half an inch thick, was ſtrong enough for the forming glaſſes to a ſphere of thirty-ſix feet diameter; when the tool was ſtrongly cemented upon a cylindrical ſtone an inch thick, with hard cement made of pitch and aſhes.

In order to make moulds for caſting ſuch tools as are pretty much concave, he directs, that wooden patterns ſhould be turned in a lathe, a little thicker and broader than the tools themſelves; but for tools that belong to ſpheres above twenty or thirty feet diameter, he ſays it is ſufficient to make uſe of flat boards turned circular to the breadth and thickneſs required. When the plates are caſt, they muſt be turned in a lathe exactly to the concavity required; and for this purpoſe it is requiſite to make a couple of braſs gages in the manner following, according to the directions of Mr. *Molyneux*.

Take a wooden pole, a little longer than the radius of the ſpherical ſurface of the glaſs to be formed; and through the ends of it ſtrike two ſmall ſteel points, at a diſtance from each other, equal to the radius of the ſphere intended; and by one of the points hang up the pole againſt a wall, ſo that this upper point may have a circular motion in a hole or ſocket made of braſs or iron, fixt firmly to the wall. Then take two equal plates of braſs or copper, well hammered and ſmoothed, whoſe length is ſomewhat more than the breadth of the tool of caſt braſs; whoſe thickneſs may be about a tenth or a twelfth of an inch, and whoſe breadth may be two or three inches. Then having faſtened theſe plates flat againſt the wall in a horizontal poſition, with the moveable point in the pole, ſtrike a true arch upon each of them. Then file away the braſs on one ſide exactly to the arch ſtruck, ſo as to make one of the braſs edges convex, and the other concave; and to make the arches correſpond more exactly, fix one of the plates flat upon a table, and grind the other againſt it with emery.

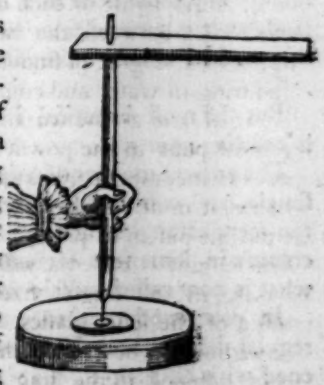
But

But if the radius of the ſphere be very great, Mr. *Huygens* directs the gages to be made as follows. Imagine the line A E, drawn upon the

braſs plate to be the tangent of the required arch A F C, whoſe radius, for example, is 36 feet, and diameter 72. From A ſet off the parts A E, E E, &c. ſeverally equal to an inch, and let them be continued a little beyond half the breadth of the tool required: then as 72 feet, or 864 inches is to 1 inch, ſo let 1 inch be to a fourth number: this will be the number of decimal parts of an inch in the firſt line E F, reckoning from A. Multiply this fourth number ſucceſſively by 4, 9, 16, 25, &c. the ſquares of 2, 3, 4, 5, &c. and the ſeveral products will be the number of parts contained in the 2d, 3d, 4th, 5th, E F reſpectively. But becauſe theſe numbers of parts are too ſmall to be taken from a ſcale by a pair of compaſſes, ſubtract them ſeverally from one inch, repreſented by the lines E G, and the remainders being taken from a ſcale of an inch divided into decimal parts, and transferred by the compaſſes from G to F, will determine the points F, F, &c. of the arch required. And the ſame being done on the other ſide of the line A D, the braſs plates muſt be filed away exactly to the points of this arch, and poliſhed as before.

Mr. *Huygens* would have his plates or tools firſt formed in a turning lathe, and then ground together with emery; that is to ſay, the concave and convex tool of the ſame ſphere together; but the tools of very large ſpheres, he would have ground at firſt quite plane, by a ſtone-cutter; and then ground hollow with a round flat ſtone and emery, to the deſired gage.

The tools thus ground muſt be poliſhed by an incruſtation of pitch and emery, and perfected with blue hones.

The glaſs being planed to an equal thickneſs, and poliſhed a little by a glaſs-grinder, and rounded by a grind-ſtone; take away the plate with ſeveral ſteel cavities, and with ſome ſifted emery, made into a cement, fix on a ſmaller round piece of braſs, or rather ſteel, truly flat, and turned, about the bigneſs of a farthing, but thicker, having firſt made in the center thereof, with a triangular ſteel punch, a hole about the bigneſs of a gooſe-quill, and about the depth of $\frac{1}{15}$ of an inch; and at the very bottom of this triangular hole, a little round hole muſt be punched ſomewhat deeper, with a very ſmall ſteel punch. A ſmall ſteel point, of about an inch long, muſt be truly ſhaped and fitted to this triangular hole, and at the very apex to the ſmall round deep impreſſion. Nevertheleſs it muſt not be fitted ſo exactly, but that it may have the liberty to move a little to and fro; the apex always continuing to preſs upon the ſurface of the round hole below. This ſteel triangular point muſt be fixed to the end of a pole; to the other end of which another round iron point muſt be fixed, of about five or ſix inches long, to play freely up and down in a round hole, in a piece of braſs let into a board, fixed againſt the ceiling for that purpoſe; perpendicularly over the bench and over the center of the tool, which muſt be ſtrongly and truly fixed horizontally thereon, as here repreſented.



Having theſe things prepared, with ſome pots of emery of various fineneſſes, take of your rougheſt ſort a ſmall pugil, wetting the ſame, and daubing it pretty equably on the tool; then lay on your glaſs, and fix up your pole, and continue to grind for a quarter of an hour; not preſſing upon the pole, but barely carrying the glaſs round thereby: then take a little quantity of ſome finer emery, and work another quarter of an hour therewith: then take the like quantity of emery ſtill finer, and work for the ſame time: laſt of all take a leſs quantity of ſome of the very fineſt you have, which will be ſufficient for a glaſs of five inches diameter, and work therewith for an hour and a half; taking away by little and little ſome of the emery with a wet ſponge. Do not keep it too wet nor too dry, but about the conſiſtence of pap: for much depends on this. If it be too dry, your emery will ſtick, clog, and incorporate, and cut little or none at all. beſides it will ſcratch and cut your glaſs irregularly; and if it is too wet, and too much diluted, it will, from the irregular ſeparation of its parts, cut in ſome places more than others, as in the other caſe.

But Mr. *Huygens* tells us, that this method of uſing various ſorts of freſh emery is not good; finding by experience, that the ſurfaces of large glaſſes are often ſcratched. And therefore he ſays, that it is beſt to take a large quantity of the firſt and ſecond emery, and ſo work with the ſame from the firſt to the laſt, taking away, by little and little, every half hour, or quarter of an hour, more and more of the emery with a wet ſponge; by which means he could bring the glaſs extremely ſmooth and

and fine, ſo as to ſee pretty diſtinctly, a candle or the ſaſh-windows well defined through it, which is a mark when it is ground enough to receive a poliſh.

When you firſt begin to grind, and the emery begins to be ſmooth, the glaſs will ſtick a little to the tool, and run ſtiff; then freſh emery is to be added.

The method hitherto deſcribed of grinding with emery, is what is recommended by Mr. *Huygens*, *Le Pere Cherubin* preſcribes another material, which is the *grit* of a hard *grind-ſtone*, well beaten into a fine powder, and ſifted pretty fine: and here in *England* the ſame thing was uſed to be performed by Mr. *Cox*, with common clean *white ſand*, taking away by little and little the ſaid grit and ſand, as it is ground finer and finer; but it ſeems this method is now quite diſuſed.

But the moſt beautiful improvement of this art is *painting upon glaſs*.

The antient manner of *painting upon glaſs* was very ſimple, and conſequently very eaſy; it conſiſted in the mere arrangement of pieces of glaſs of different colours in ſome ſort of ſymmetry, and conſtituted what is now called moſaic work.

In proceſs of time they came to attempt more regular deſigns, and alſo to repreſent figures heightened with all their ſhades: yet they proceeded no farther than the contours of the figures in black with water-colours, and hatching the draperies after the ſame manner, on glaſſes of the colour of the object they deſigned to paint. For the *carnation*, they uſed glaſs of a bright *red colour*; and upon this they drew the principal lineaments of the face, *&c.* with black.

But in time, the taſte for this ſort of painting improving conſiderably, and the art being found applicable to the adorning of churches, *&c.* they found out means of incorporating the colours in the glaſs itſelf, by heating them in the fire to a proper degree; having firſt laid on the colours.

The colours uſed in *painting* or *ſtaining* of *glaſs*, are very different from thoſe uſed in painting either in water or oil colours.

For *black*, take ſcales of *iron*, one ounce; ſcales of *copper*, one ounce; *jet*, half an ounce; reduce them to powder, and mix them. For *blue*, take *powder of blue*, one pound; *ſal nitre*, half a pound; mix them and grind them well together. For *carnation*, take *red chalk*, eight ounces; *iron* ſcales and *litharge* of ſilver, of each two ounces; *gum arabic*, half an ounce; diſſolve in water; grind all together for half an hour as ſtiff as you can; then put it in a glaſs and ſtir it well, and let it ſtand to ſettle fourteen days. For *green*, take *read lead*, one pound; ſcales of *copper*, one pound; and *ſtint*, five pounds; divide them into three parts; and add to them as much *ſal nitre*; put them into a crucible, and melt them with a ſtrong fire; and when it is cold, powder it, and grind it on a porphyry. For *gold colour*, take *ſilver*, an ounce; *antimony*, half an ounce; melt them in a crucible; then pound the maſs to powder, and grind it on a copper plate; add to it *yellow oker*, or *brick-duſt* calcined again, fifteen ounces; and grind them well together with water. For *purple*, take *minium*, one pound; *brown ſtone*, one pound; white *ſtint*, five pounds; divide them into three parts, and add to them as much *ſal nitre* as one of theſe parts; calcine, melt, and grind it as you did the green. For *red*, take *jet*, four ounces; *litharge* of ſilver, two ounces; *red chalk*, one ounce; powder them fine, and mix them. For *white*, take *jet* two parts; white *ſtint*, ground on a glaſs very fine, one part; mix them. For *yellow*, take *ſpaniſh brown*, ten parts; *leaf-ſilver*, one part; *antimony*, half a part; put all into a crucible, and calcine them well.

Thoſe beautiful works which were made in the glaſs-houſes were of two kinds. In ſome, the colour was diffuſed through the whole ſubſtance of the glaſs. In others, which were the more common, the colour was only on one ſide, ſcarce penetrating within the ſubſtance above one third of a line; though this was more or leſs according to the nature of the colour; the yellow being always found to enter the deepeſt. Theſe laſt, though not ſo ſtrong and beautiful as the former, were of more advantage to the workmen, by reaſon that on the ſame glaſs, tho' already coloured, they could ſhew other kind of colours, where there was occaſion to embroider draperies, enrich them with foliages, or repreſent other ornaments of gold, ſilver, *&c.*

In order to this, they made uſe of emery, grinding or wearing down the ſurface of the glaſs, till ſuch time as they were got through the colour to the clear glaſs. This done, they applied the proper colours on the other ſide of the glaſs. By this means, the new colours were hindered from running and mixing with the former, when they expoſed the glaſſes to the fire.

When indeed the ornaments were to appear white, the glaſs was only bared of its colour with emery, without tinging the place with any colour at all; and this was the manner by which they wrought their lights, and heightenings, on all kinds of colour.

The firſt thing to be done, in order to paint, or ſtain glaſs, in the modern way, is to deſign, and even colour the whole ſubject on paper. Then they chooſe ſuch pieces of glaſs as are clear, even, and ſmooth, and proper to receive the ſeveral parts, and proceed to diſtribute the deſign itſelf, or papers

it

it is drawn on, into pieces ſuitable to thoſe of the glaſs; always taking care that the glaſſes may join in the contours of the figures, and the folds of the draperies; that the carnations, and other finer parts, may not be impaired by the lead with which the pieces are to be joined together. The diſtribution being made, they mark all the glaſſes as well as papers, that they may be known again: which done, applying every part of the deſign upon the glaſs intended for it, they copy, or transfer, the deſign upon this glaſs with the black colour diluted in gum water, by tracing and following all the lines and ſtrokes as they appear through the glaſs, with the point of a pencil.

When theſe ſtrokes are well dried, which will happen in about two days, the work being only in black and white, they give a ſlight waſh over with urine, gum arabic, and a little black; and repeat it ſeveral times, according as the ſhades are deſired to be heightened, with this precaution, never to apply a new waſh till the former is ſufficiently dried.

This done, the lights and riſings are given by rubbing off the colour in the reſpective places with a wooden point, or the handle of the pencil.

As to the other colours above-mentioned, they are uſed with gum-water, much as in painting in miniature; taking care to apply them lightly for fear of effacing the out-lines of the deſign; or even, for the greater ſecurity, to apply them on the other ſide; eſpecially yellow, which is very pernicious to the other colours, by blending therewith. And here too, as in pieces of black and white, particular regard muſt always be had not to lay colour on colour, or lay on a new lay, till ſuch time as the former are well dried.

It may be added, that the yellow is the only colour that penetrates through the glaſs, and incorporates therewith by the fire; the reſt, and particularly the blue, which is very difficult to uſe, remaining on the ſurface, or at leaſt entering very little. When the painting of all the pieces is finiſhed, they are carried to the furnace, or oven, to anneal, or bake the colours.

The furnace here uſed is ſmall, built of brick, from eighteen to thirty inches ſquare; at ſix inches from the bottom is an aperture to put in the fuel, and maintain the fire. Over this aperture is a grate, made of three-ſquare bars of iron, which traverſe the furnace, and divide it into two parts. Two inches above this partition, is another little aperture, through which they take out pieces to examine how the coction goes forward. On the grate is placed a ſquare earthen pan, ſix or ſeven inches deep; and five or ſix inches leſs every way than the perimeter of the furnace. On the one ſide hereof is a little aperture, through which to make trials, placed directly oppoſite to that of the furnaces deſtined for the ſame end. In this pan are the pieces of glaſs to be placed, in the following manner: Firſt, the bottom of the pan is covered with three ſtrata, or layers, of quick lime pulverized; thoſe ſtrata being ſeparated by two others of old broken glaſs, the deſign whereof is to ſecure the painted glaſs from the too intenſe heat of the fire. This done, the glaſſes are laid horizontally on the laſt or uppermoſt layer of lime.

The firſt row of glaſs they cover over with a layer of the ſame powder, an inch deep; and over this, they lay another range of glaſſes, and thus alternately till the pan is quite full; taking care that the whole heap always end with a layer of the lime-powder.

The pan being thus prepared, they cover up the furnace with tiles, on a ſquare table of earthenware, cloſely luted all round; only leaving five little apertures, one at each corner, and another in the middle, to ſerve as chimnies. Things thus diſpoſed, there remains nothing but to give the fire to the work. The fire for the firſt two hours muſt be very moderate, and muſt be increaſed in proportion as the coction advances, for the ſpace of ten or twelve hours; in which time it is uſually compleated. At laſt the fire, which at firſt was charcoal, is to be of dry wood, ſo that the flame covers the whole pan, and even iſſues out at the chimnies.

During the laſt hours, they make eſſays, from time to time, by taking out pieces laid for the purpoſe through the little aperture of the furnace, and pan, to ſee whether the yellow be perfect, and the other colours in good order. When the annealing is thought ſufficient, they proceed with great haſte to extinguiſh the fire, which otherwiſe would ſoon burn the colours, and break the glaſſes.

GLAZING.

GLAZING.

GLAZING is the art of poliſhing or cruſting over *earthen-ware*, by running melted lead or litharge over the clay-veſſel, *&c.*

The common ware is glazed with a compoſition of 50 lb. clean ſand, 70 lb. lead-aſhes, 30 lb. wood-aſhes, and 12 lb. ſalt, all melted into a cake. With this mixture they glaze it over, and then ſet it in an earthen glazing pan; taking care that the veſſels do not touch one another. As ſeveral colours are uſed for this purpoſe, we ſhall give the following receipts, from *Smith*'s Laboratory. 1. For a black, take lead-aſhes, 18 parts; iron filings, 3; copper-aſhes, 3; and zaffer, 2: this, when melted, will make a brown black; and if you would have it blacker, put ſome more zaffer to it. 2. For blue, take lead-aſhes, 1 lb. clear ſand or pebble, 2 lb. ſalt, 2 lb. white calcined tartar, 1 lb. venice or other glaſs, 16 lb. and zaffer, half a pound: mix them well together; and after melting quench them in water, and then melt them again; which operation is to be repeated ſeveral times; and if you would have it fine and good, it will be proper to put the mixture into a glaſs furnace for a day or two. 3. A brown glazing may be given with a mixture of lead-glaſs, 12 parts, and common glaſs and manganeſe, of each one part. 4. A citron-yellow may be made of 6 parts of red-lead, 7 parts of fine red brick duſt, and two parts of antimony, all melted together. 5. A fleſh-colour, with 12 parts of lead-aſhes, and 1 of white glaſs. 6. For a green-colour, take 8 parts of litharge, 8 parts of venice glaſs, 4 parts of braſs duſt, and melt them together for uſe; or melt together two parts yellow-glaſs, with as much copper-duſt. 7. For a gold-yellow, take of antimony, red-lead, and ſand, an equal quantity, and melt them into a cake. 8. For a fine purple brown, take lead-aſhes, 15 parts; clear ſand, 18; manganeſe, 1; white glaſs, 15 meaſures; and one of zaffer. 9. For a fine red, take antimony, 2 lb. litharge, 3 lb. ruſt of iron calcined, 1 lb. and grind them to a fine powder. 10. For a fine white glazing, take 2 lb. of lead, 1 lb. of tin, and calcine them to aſhes; of which take 2 parts; of calcined flint or pebble, 1 part; of ſalt, 1 part; and mixing them well together, melt them into a cake. At *Rotterdam*, they make a fine ſhining white glazing, by melting together 2 lb. clean tin-aſhes, 10 lb. lead-aſhes, 2 lb. fine venice glaſs, and half a pound tartar. 11. A yellow glazing is made of 4 ounces of red-lead, and two ounces of antimony, melted together. 12. For a fine yellow, take red lead, 3 pints; antimony and tin, of each 2 lb. then melting them into a cake, grind it fine; and repeating this ſeveral times, you will have a good yellow.

GOLD-BEATING.

THIS is the art of reducing *gold* into exceeding thin leaves: for which purpoſe there muſt be choſen *gold* with as little alloy as poſſible.

The *gold-beater*'s ſhop is furniſhed with a ſmall forge, a ſmall anvil, crucibles, *&c.* and likewiſe with three ſorts of hammers formed like mallets, of poliſhed iron. The firſt, which is to weigh three or four pounds, will ſerve to chace, or drive; the ſecond, of eleven or twelve pounds, to cloſe; and the third, which muſt weigh fourteen or fifteen pounds, to ſtretch and finiſh. Beſides this, there muſt be a block of black marble, about a foot ſquare, and which is to be raiſed three foot high; and alſo four moulds of different ſizes, *viz.* two of vellum, the ſmalleſt whereof muſt conſiſt of forty or fifty leaves; and the largeſt of two hundred; the other two conſiſting each of five hundred leaves, made of bullocks guts well ſcoured and prepared.

Proceed to work, by melting a proper quantity of *gold*, and forming it into an ingot; this done, reduce that ingot, by forging, into a plate about the thickneſs of a ſheet of paper; and then cut it into little pieces, about an inch ſquare, and lay them in the firſt, or ſmalleſt mould, to begin to ſtretch them. After they have been hammer'd here a while with the ſmalleſt hammer, cut each of them into four; and put them into the ſecond mould, to be extended further.

Upon taking them hence, cut them again into four, and put them into the third mould; out of which they are taken, divided into four as before, and laid in the laſt or finiſhing mould, where beat them to the degree of thinneſs required: obſerving that the *gold* is beaten more or leſs according to the

the kind or quality of the work it is intended for: that for the gold-wire-drawers to gild their ingots withal, muſt be left thicker than that for gilding frames of pictures, &c. withal.

It is computed that an ounce may be beaten into ſixteen hundred leaves, each three inches ſquare; in which ſtate it takes up more than 15.9092 times its former ſpace.

The leaves thus finiſhed are taken out of the mould, and diſpoſed in little paper books prepared with red bole, for the gold to ſtick to: each book ordinarily containing twenty-five gold leaves. There are two ſizes of theſe books; twenty-five leaves of the ſmalleſt only weighs five or ſix grains; and the ſame number of the largeſt nine or ten grains.

Shell-gold uſed by the illuminers, and wherewithal we write gold letters, is made of the parings of leaf-gold, and even of the leaves themſelves, reduced into an impalpable powder, by grinding on a marble with honey: and after it has been left to infuſe ſome time in aqua-fortis, it is put in ſhells where it ſticks.

GOLD-WIRE-DRAWING.

GOLD-WIRE-DRAWING, is the method of managing gold in order to fit it to be ſpun on ſilk, or to be uſed flat as it is, without ſpinning, in certain ſtuffs, laces, embroideries, &c.

The operation is performed by forging, firſt, an ingot of ſilver of twenty-four pounds into a cylinder about an inch in diameter: then drawing it through eight or ten holes of a large coarſe wire drawing iron, both to finiſh the roundneſs, and to reduce it to about three fourths of its former diameter. This done, it is filed very carefully all over, to take off any filth remaining of the forge: then it is cut in the middle, making thus two equal ingots thereof, each about 26 inches long, which are drawn through ſeveral new holes, to take off any inequalities the file may have left, and to render it as ſmooth and equal as poſſible.

The ingot thus prepared, is heated in a charcoal fire; then taking ſome gold leaves, each of about four inches ſquare, and weighing twelve grains; four, eight, twelve, or ſixteen of theſe are joined together, as the wire is intended to be more or leſs gilt; and when they are ſo joined as only to make a ſingle leaf, the ingots are rubbed reeking hot with a burniſher.

Theſe leaves thus prepar'd, are applied over the whole ſurface of the ingot to the number of ſix, over each other; burniſhing or rubbing them well down with the blood-ſtone, to cloſe and ſmoothen them.

When gilt, the ingots are laid a new in a coal-fire; and when raiſed to a certain degree of heat, the artiſt goes over them a ſecond time with the blood-ſtone, both to ſolder the gold more perfectly, and to finiſh the poliſhing.

The gilding finiſhed, it remains to draw the ingot into wire. In order to this, it is paſſed through twenty holes of a moderate drawing-iron, by which it is brought to the thickneſs of the tag of a lace: from this time, the ingot loſes its name, and commences *gold-wire*. Twenty holes more of a leſſer iron, leave it ſmall enough for the leaſt iron: the fineſt holes of which laſt, ſcarce exceeding the hair of the head, finiſh the work.

Before the wire be reduced to this exceſſive fineneſs, it is drawn through above an hundred and forty different holes; and each time they draw it, it is rubbed freſh over with new wax, both to facilitate its paſſage, and to prevent the ſilver appearing through.

To diſpoſe the wire to be ſpun on ſilk, they paſs it between two rollers of a little mill. Theſe rollers are of poliſhed ſteel, and about three inches in diameter. They are ſet very cloſe to each other, and turn'd by a handle faſten'd to one of them, which gives motion to the other. The *gold wire* in paſſing between the two, is render'd quite flat; but without loſing any thing of its gilding; and is render'd ſo exceedingly thin and flexible, that it is eaſily ſpun on ſilk-thread, by a hand-wheel, and ſo wound on a ſpool or bobbin.

The prodigious ductility, which makes one of the diſtinguiſhing characters of gold, is no where more conſpicuous than in this gilt wire. A cylinder of 48 ounces of ſilver, cover'd with a coat of gold, Dr. *Halley* informs us, is commonly drawn into a wire, two yards of which weigh only one grain: whence ninety-eight yards of the wire weigh only forty-nine grains. And one ſingle grain of gold covers the ſaid ninety-eight yards: ſo that the ten thouſandth part of a grain, is above half an inch long. The ſame author computing the thickneſs of the ſkin of gold, found it to be only $\frac{1}{134100}$ part of an inch. Yet ſo perfectly does it cover the ſilver, that even a microſcope does not diſcover any appearance of the ſilver underneath. Mr. *Rohault* obſerves, that a like cylinder of ſilver

cover'd with gold, two feet eight inches long, and two inches nine lines in circumference, is drawn into a wire 307200 feet long; *i. e.* into 115200 its former length. Mr. *Boyle* relates, that eight grains of gold, covering a cylinder of ſilver, is commonly drawn into a wire 30000 feet long.

GRAMMAR.

THOSE who are well verſed in *Grammar*, or who teach *Grammar*, are called *Grammarians*. — The *Grammarian* is conceived as a perſon wholly attentive to the *minutiæ* of language; induſtriouſly employed about words and phraſes; incapable of perceiving the beauties, delicacy, extent, *&c.* of a ſentiment. *Scaliger*, however, conſidered *Grammarians* in another light; *utinam eſſem*, ſays he, *bonus* grammaticus: *ſufficit enim ei, qui omnes authores vult intelligere, eſſe* grammaticum. — The title *Grammarian*, it is certain, was antiently a title of honour; being given not only to ſuch as applied themſelves to *Grgmmar*, or excelled in philology; but to all who were reputed learned in any art, or faculty whatever; as is ſhewn by *Ger. Voſſius*, in his book of *Grammar*. The word was properly a title of literature and erudition, and frequently given to perſons who excelled in all, or many arts, call'd alſo *Polyhiſtores*. Thus *Philoponus*, a famous philoſopher in *Juſtinian*'s time, remarkable for the extent and variety of his knowledge, was ſurnamed *Grammaticus*. So *Saxo*, the *Daniſh* hiſtorian, in the 13th century, got the appellation *grammaticus:* and as late as the year 1580, *Thomas d' Averſa*, the famous *Neapolitan* lawyer, was ſurnamed the *Grammarian*.—The title *grammarian* was antiently beſtow'd on thoſe we now call *criticks*, men of learning, erudition, letters, *&c.* and particularly ſuch as wrote well, and politely in every kind. It is in this ſenſe that *Suetonius* entitles his book, which he wrote on the beſt *Latin* authors, *of the celebrated grammarians*; and that *Cornelius Nepos* calls the commentators on the orators, and poets, *grammarians*. And laſtly, it is in this ſenſe the apellation is attributed, by the antients to *Apion*, *Philopemus*, and *Solinus*.—The moſt celebrated *grammarians* of the ſecond century, were *Aper*, *Pollio*, *Eutychius*, *Proculus*, *Athæneus*, *Julius Pollux*, *Macrobius*, and *Aulus Gellius*. The works of theſe laſt authors are an aſſemblage of abundance of very different things and ſubjects, relating to the criticiſms of the antient writers, and polite literature.—If the name have loſt its antient honour, it is through the fault of thoſe who have aſſumed it; by treating of *grammar* in a low, pedantick, and dogmatick manner; reducing it to words and ſyllables; and dwelling altogether on trifling, puerile remarks and cenſures, whereas its antient office was to make an accurate, and thorough examen of an author; to enter into all his views, to point out the beauties and the defects thereof; to diſtinguiſh the true beauties from the falſe; and the genuine productions of an author from the ſuppoſititious: that is, a *grammarian* was then, what we call *a critick* now.—Thoſe who only taught to read, underſtand, and explain authors, were call'd *grammaticks*, *grammatiſtæ*; in contradiſtinction from *grammatici:* though, in courſe of time, the *grammatiſtæ* have roſe into the place of *grammatici*, who are preferred to that of *critici*.

Diogenes Laertius relates, after one *Hermippus*, that *Epicurus* was the firſt who gave the rules of *grammar* for the *Greek* tongue; but that *Plato* was the firſt who had taken the thing into conſideration, and even made ſome diſcoveries on that ſubject.—At *Rome*, *Crates*, ſurnamed *Malletes*, contemporary with *Ariſtarchus*, gave the firſt lectures thereon to the *Romans*, during the time of his being embaſſador for King *Attalus*, to the common-wealth, between the ſecond and third *Punick* wars, ſoon after *Ennius*'s death. Before him it was not known at *Rome* what *grammar* meant.

GRAMMAR is the art of ſpeaking and writing a language with propriety, or correctneſs; and it is divided by ſome authors into four parts, *Orthography*, *Proſody*, *Etymology*, and *Syntax*.

Others chuſe to divide *grammar* ſomewhat more obviouſly, into the doctrine of *letters* or *ſounds*, which coincides with *orthography*, and *orthopy*; that of *ſyllables*, their accent, time, *&c.* which falls in with *proſody*; that of *words*, their kinds, derivations, changes, analogy, *&c.* which amounts to *etymology*; and that of *ſentences*, which conſiders the placing or joining of words together, called *ſyntax*.

Grammar is the ſame in all *languages*, as to its *general principles* and notions, which it borrows from *philoſophy*, to explain the order and manner, wherein we expreſs our *ideas* by *words*; but as each language has its particular *turns*, its ſeveral *characters* and *genius*, different from the genius and character of other languages, hence ariſe as many

grammars

grammars as *languages* Therefore to give a true notion of thoſe ſeveral different languages, I muſt take notice in this treatiſe, of the moſt *eſſential rules* peculiar to each different *grammar*; and as the *doctrine* of LETTERS is the firſt part of our diviſion of *grammar*, we'll begin, as all grammarians do, with the ALPHABET, which is the ſeveral *letters* of a language, diſpos'd in their natural or accuſtom'd order; and as there are as many ſorts of *alphabets*, likewiſe, as there are *languages*, (for this they may uſe the ſame *character* or *letters*, they differ in the pronunciation of theſe letters) I'll give here ſome of thoſe different ſorts, *viz.* the *Engliſh*, *French*, *Latin*, *Greek*, and *Hebrew*.

ENGLISH.	FRENCH.		LATIN.		HEBREW.				GREEK.			
26 *Letters*	24 *Letters*	*Pronunciation.*	22 *Letters*	*pronounced like* French.	*Names.*	*Figures.*	*Similitudes.*	*Powers.*		*Figures.*	*Names.*	*Powers.*
a	a	aw	a					*ſpiritus*		Α α	Alpha	a
b	b	bé	b		Aleph	א		*lenis*	1	Β β ϐ	Beta	v
c	c	cé	c		Bheth	ב		bh	2	Γ γ ϝ	Gamma	g
d	d	dé	d		Ghimel	ג		gh	3	Δ δ	Delta	d
e	e	cé	e		Dhaleth	ד		dh	4	Ε ε	Epſilon	e, *breve*
f	f	ef	f		He	ה	ה	h	5	Ζ ζ	Zeta	z
g	g	gé	g		Vau	ו	ו	v, *Con.*	6	Η η	Eta	e, *longum*
h	h	aſhe	h		Zajin	ז		z	7	Θ θ ϑ	Theta	th
i	i		i		Cheth	ח		hh	8	Ι ι	Iota	i
j	l	ell	l		Teth	ט	ם	t	9	Κ κ	Kappa	k, c
k	m	m	m		Jodh	י		j, *Con.*	10	Λ λ	Lambda	l
l	n	n	n		Chaph	כ ך		ch, x	20	Μ μ	Mu	m
m	o	o	o		Lamed	ל		l	30	Ν ν	Nu	n
n	p	pé	p		Mem	מ ם	ם	m	40	Ξ ξ	Xi	x
o	q	kûu	q		Nun	נ ן		n	50	Ο ο	Omicron	o, *parvum*
p	r	r	r		Samech	ס		ſ, *acutum*	60	Π π ϖ	Pi	p
q	ſ	ſ	ſ		Ghnajin	ע		ghn, ngh	70	Ρ ϱ ῥ	Rho	r
r	t	té	t		Phe	פ ף		ph	80	Σ ϹC σ ς	Sigma	ſ
ſ	u	ue	u		Tzade	צ ץ		tſ	90	Τ τ ϯ	Tau	t
t	w		x		Koph	ק		k	100	Υ υ	Upſilon	u
u	x		y		Reſch	ר		r	200	Φ φ	Phi	ph
v	y	e *Greek*	z		Schin	ש		ſch ſh	300	Χ χ	Chi	ch
w	z	zede			Sin	ש		ſ		Ψ ψ	Pſi	pſ
x					Thau	ת		th	400	Ω ω	Omega	o, *magnum*
y												
z												

It is proper here to obſerve, that the *Chaldee*, *Syriac*, and *Samaritan* alphabets, have, like the *Hebrew*, each 22 letters; the *Arabick* 28; the *Perſian* 31; the *Turkiſh* 33; the *Georgian* 36; the *Coptick* 32; the *Muſcovite* 43; the *Sclavonian* 27; the *Dutch* 26; the *Spaniſh* 27; the *Italians* of *Bengal* 21; the *Baramas* 19; and the *Ethiopick* no leſs than 202; there being 7 vowels, which they combine with each of their 26 conſonants; to which they add 20 other aſpirated ſyllables. The like is ſaid of the *Tartarian*, each of their letters is a ſyllable, having one of the vowels join'd to its conſonant, as *la*, *le*, *li*, &c. The *Chineſe* have no alphabet, properly ſpeaking, except we call their whole language their alphabet; their *letters* are *words*, or rather *hieroglyphicks*, and are in number about 80,000.

Note alſo, That alphabets were not contrived with deſign, according to the juſt rules of reaſon, and analogy; but ſucceſſively framed and altered, *&c.* as occaſion offered.

The *characters* now uſed in all the alphabets of modern languages, throughout all *Europe*, are the *Latin* Characters of the antients.

Theſe *characters* are divided, by *grammarians*, into *vowels* and *conſonants*; into *mutes*, *dipthongs*, *liquids*, and *characteriſticks*; and are commonly called *letters*.

A VOWEL, is a letter which affords a compleat ſound of itſelf; or a letter ſo ſimple, as only to

need a bare opening of the mouth to make it heard, and to form a diſtinct voice. Such are *a*, *e*, *i*, *o*, *u*; which are called *vowels*, in contradiſtinction to certain other letters, which depending on a particular application of ſome part of the mouth, as the *teeth*, *lips*, or *palate*, can make no perfect ſound without an opening of the mouth, that is, without the addition of a vowel; and are therefore called conſonants.

Though we ordinarily only reckon five vowels, yet, beſides, that each of theſe may be either long, or ſhort, which occaſions a conſiderable variety in the ſound; to conſider only their differences reſulting from the different aperture of the mouth in the *Engliſh* pronunciation, one might add four or five more vowels to the number.—For the *e* open, and the *e* cloſe, are different enough to make two vowels, as in *ſea* and *depth*; ſo alſo the *o* open, and *o* cloſe, in *hoſt* and *organ*. Add, that the *u* pronounced *ou*, as the *Latins* did, and as *Italians* ſtill do, has a very different ſound from the *u*, as pronounced by the *Greeks*, and as at this day by the *French* and *Engliſh*.—Again, *eo*, in *people*, make but one ſingle ſound, though written with two vowels.

Laſtly, the *e* mute is, originally, no more than a ſurd joined to a conſonant, when that is to be pronounced without a vowel, as when it is immediately followed by other conſonants. Thus, without regarding the differences of the ſame ſound, or vowel, as to length or ſhortneſs, one may diſtinguiſh ten ſeveral vowels, expreſſed by the following characters *a*, *é*, *i*, *o*, *ô*, *eu*, *ou*, *u*, *e*, mute.

The CONSONANT, is a letter, which produces no ſound alone, or without ſome vowel joined with it: and conſidered philoſophically, it is nothing elſe but the modification of a ſound, produced by means of the organ of the voice, not a production of ſound itſelf: thus *v. gr.* the ſounds ſignified by the characters, *a*, *e*, *i*, *o*, *u*, are differently modified, when we ſay *ab* than when we ſay, *ac*, or *ca*, *ad*, or *da*; and thoſe modifications are called *conſonants*.

Conſonants are divided into ſingle, as *b*, *h*, *m*, *q*, &c. and double, as *ax*, in *axillary*; corresponding to the ξ of the *Greeks*.

Conſonants, again, are divided into liquid, as *l*, *r*, *m*, *n*; and mute, as *b*, *d*, and the reſt, which make no ſound at all without a vowel.

But the *Hebrew* grammarians, who have been imitated therein by the grammarians of other oriental languages, divide the *conſonants* into *five claſſes*, with regard to the five principal organs of the voice.

Theſe organs are the *throat*, *palate*, *tongue*, *teeth*, and *lips*; whence the five claſſes of conſonants are denominated *guttural*, *palatal*, *lingual*, *dental*, and *labial*.

There are ſixteen conſonants in the *Engliſh* alphabet, *viz. b*, *c*, *d*, *f*, *g*, *k*, *l*, *m*, *n*, *p*, *q*, *r*, *s*, *t*, *x*, *z*; to which the *h*, the *j* conſonant, and *v* conſonant, make the whole number of conſonants nineteen; one whereof is *guttural*, viz. the aſpirate *h*; five *palatal*, viz. *c*, as when pronounced before *a*, *o*, and *u*, as in *cavern*, *corn*, *curioſity*; *g*, as in *Geneva*; *j* conſonant in *julep*; *k*, in *kernel*; and *q*, in *query*.—The four *lingual conſonants* are *d*, *l*, *n*, *t*; the four dental are, *r*, *s*, *x*, *z*; the three laſt whereof are hiſſers; and five labial, *b*, *f*, *m*, *p*, and *v* conſonant.

With regard to which diviſion, it may be obſerved, that though the *g* be modified in three different manners, as is comes before an *a*, an *o*, or an *u*; yet it is ſtill a conſonant of the palate; that the *j* conſonant differs, in nothing but its figure, from the *g* before *e*, or *i*; that *k* has the ſame pronunciation with the *c*; that *x* comprehends the ſound of two letters in its ſound, *viz. c*, or *k*, and *ſ*, or another *c*, as in *Alexander*, and in *Alexis*, which we pronounce as if wrote *Alecſander*, and *Aleccis*, or *Alecſis*; and that the *c* before an *e* or *i* is no conſonant of the palate, becauſe in that caſe it loſes its proper ſound, and aſſumes the hiſſing ſound of the *ſ*.

The exceſs of conſonants, in one language above another, only conſiſts in this, that there are more modifications of ſound received, and eſtabliſhed in the one than in the other; for all men, having the ſame organs, may form the ſame modifications; ſo that it is entirely owing to cuſtom, nothing to nature, that the *Engliſh* have not the ϑ of the *Greeks*, the *Ain* and *Heth* of the *Hebrews*, the *ch* of the *Germans*, the *gn* of the *French*, the *gl* of the *Italians*, the *ll* of the *Welch*, &c.

Alſo that the *Chineſe* have no *r*, the *Iroquis* no labial conſonants, the *Hurons* abundance of aſpirates; and the *Arabs* and *Georgians* abundance of double conſonants; which laſt is owing to this, that they make ſeveral organs concur ſtrongly, and equally to the modification of a ſound; whereas, in the reſt, only one organ is moved very ſtrongly and ſenſibly, and the reſt weakly.

It is alſo viſible, that, in all languages, the aſpirates, or guttural letters are real conſonants, ſince the throat modifies the ſound as much as the palate, tongue, or lips.

Laſtly, To find all the conſonants that may be formed in any language, there needs nothing but to obſerve all the modifications that the ſounds of ſpeech will admit of, by which we ſhall have all the conſonants practicable.

An *aſpirate* is alſo a *modificative*, or *conſonant*, as having all the properties of a *conſonant*; for, 1. It reſults from a motion of the organ, which of itſelf

ſelf produces no ſound; thus the *ſpiritus* of the *Greeks*, the *French*, and *Engliſh h* aſpirate, has no more ſound of itſelf than *b*, *c*, *d*, &c. and the ſame thing may be obſerved of the *Aleph*, *Beth*, and *Caph*, of the eaſtern languages. 2. On the contrary the *Engliſh h*, the *ſpiritus* of the *Greeks*, and the other aſpirates juſt mentioned, are pronounced with all the vowels, in the ſame manner as *conſonants* are. They modify thoſe vowels, and are effects of a motion of the organ ſuperadded to the motion neceſſary to form the vowel. Thus to pronounce *ha*, two motions of the organ are required as well as for *ba* or *ca*, &c. one for *a*, which itſelf is a ſound; the other for *h*, which yields no ſound no more than *b*, but adds ſomething to *a*, which modifies it, and makes that *ha* in not mere *a*, nor *ba*, nor *ca*, &c. and this muſt hold ſtill more ſenſibly in the ſtronger aſpirates of the oriental tongues; in all which there are evidently two motions, the one for the vowel, and the other to modify it: now this being the nature and eſſence of a conſonant, it follows, that let them be denoted in what manner they will, whether as the *Engliſh h*, as the oriental *do*, i. e. by proper characters in the courſe of the words themſelves; or, as the *Greeks* do ſome of theirs, by a ſign of aſpiration placed over the vowel, it matters not. The *aſpirate* is no leſs a conſonant in ἁιρω than in χαιρω; in ω, than in χιω; in ὁλη than in χολη; and ſo of others. The third and laſt reaſon is, that the eaſtern languages, which do not expreſs the vowels, do yet expreſs the aſpirates. Add, that the aſpirate is frequently changed into a conſonant, and expreſſed by a conſonant: thus if ἑξ is made *ſex*; of ἑπτα, *ſeptem* of ἑσπερος, *Veſperus*, &c. of the *Hebrew* יין, οἰνος, and thence *Vinum*, &c. nay even in the ſame language, *Heſiod* ſpeaking of *Hercules*'s buckler, uſes Ἡρων for Θηρων; making no difference between a Θ and an aſpirate. Hence it evidently follows, that aſpirates are real conſonants; and that it muſt be an error to rank א, ה, ע, of eaſtern languages among the vowels; and to exclude the *h* in *Engliſh* out of the number of letters.

Mute letters, are thoſe which are not ſounded, or heard in the pronunciation, or letters which yield no ſound of themſelves, and without a vowel.

The *mutes* in the *Engliſh* alphabet are eleven, *viz. B*, *C*, *D*, *F*, *G*, *J*, *K*, *P*, *Q*, *T*, *V*. They are called *mutes*, becauſe a liquid cannot be ſounded in the ſame ſyllable before them, as *repo*; but a *mute* may be pronounced in the ſame ſyllable before a liquid, as *pro*.

Liquids are certain conſonants oppoſed to *mutes*; *l*, *m*, *n*, and *p*, are *liquids*.

Dipthong is a double vowel, or the union, or mixture of two vowels pronounced together, ſo as only to make one ſyllable; as the *Latin a e*, *æ*, *o e*, or *œ*; the *Greek αι*, *ει*; the *Engliſh ai*, *au*, &c.

Ae anſwers to *ai*, the proper, and *æ* the improper dipthong of the *Greeks*, *e. g.* Αινεας; *Aneas*; σφαιρα *Sphaerae*, &c. And on the contrary, the *Romans* when they had occaſion to divide their *ae*, changed it into the *Greek ai*, *e. g. aulai* for *aulae*, &c.

Ai by ſome is made a *Latin* dipthong, as in *aio*, *caius*, &c. But in *ais* and *ait*, *i* manifeſtly belongs to the latter ſyllable; and the *Greeks* write not Γαΐος, but Γαιος; whence it ſeems plain that *ai* in the *Latin* tongue is not a dipthong as in the *Greek*.

The *Latins* pronounced the two vowels in their *dipthongs* much as we do, with this exception, that the two were not heard equally, but the one was ſomewhat weaker than the other, though the diviſion was made with all the delicacy imaginable. Among the *Engliſh* moſt of the *Latin* dipthongs are loſt in the pronunciation; their *æ* and *œ* are only ſpoke as *e's*, ſo as alſo the *Engliſh ea*, *oa*, &c. though wrote with two characters, are pronounced as ſimple ſounds.

In *French*, *Engliſh*, and divers other languages, one may diſtinguiſh *dipthongs* with regard to the eye, from *dipthongs* with regard to the ear.

Engliſh dipthongs proper, are *ai*, as in *fair*; *au*, in *laud*; *ee*, in *bleed*; *oi*, in *void*; *oo*, in *food*; and *ou*, in *houſe*.

Engliſh improper dipthongs, are *aa*, pronounced only like *a*, as in *Aaron*; *ea*, like *a*, as in *ſwear*, *heart*; or like *e*, as *already*; or like *ee*, as *veal*: *eo*, like *e*, in *feoffe*; or like *o*, in *George*: *eu*, or *ew*, like *u*, as *Deuteronomy*; *ie*, like *e*, as *cieling*, *field*: *ei*, like *a*, in *feign*; or like *e*, in *deceit*: *oa*, as in *cloak*, *doat*: *oe* as *doe*, *œconomy*: *ue*, as in *gueſs*: and *ui* as in *guile*, *recruit*.

From theſe different diviſions of letters, we'll paſs to every letter of our alphabet.

A is a vowel, and the firſt letter of the *French Engliſh*, and moſt other alphabets; and it is obſerved to be that, which dumb perſons are ſooneſt taught to pronounce. The reaſon is, that it does not depend on the muſcles, and other organs of the mouth and tongue, which are generally wanting in mutes; but on thoſe of the throat and noſe, which they commonly have.

It is ſo much the Language of Nature, that upon all ſudden and extraordinary occaſions we are neceſſarily led to it, as the inſtrument readieſt at hand. With this we ſpeak our admiration, joy, anguiſh, averſion, apprehenſion of danger, &c. where the paſſion is very ſtrong, we frequently enforce the *A*, by adding an Aſpirate, as *ah*.

It

It is obſerved of the *Engliſh* pronunciation, that they ſpeak the *A* with a ſlenderer and more puny ſound than any of their neighbours: Ordinarily it is ſcarce broad enough for a *French* E neuter; and comes far ſhort of the groſs *A* of the *Germans*, which would make their *au* or *aw*, or *o*.—In ſome words, however, as *talk*, *wall*, *ſtall*, &c. the *A* is broad, and deep enough; but this, it is obſerved, may not be the mere ſound of *A*, but the effect of the antient orthography, which, as low as queen *Elizabeth*, frequently added an *u* to the *A*, and wrote *taulk*, &c.

B, the ſecond letter of moſt alphabets, is the firſt conſonant, and firſt mute, and in its pronunciation is ſuppoſed to reſemble the bleating of ſheep.

B is alſo a *Labial*, becauſe the principal organs employed in its pronunciation are the lips. It has a near affinity with the other *labials* P and V, and is often uſed for P, both by the *Armenians*, and other orientals; as in *Betrus* for *Petrus*, *Apſens* for *Abſens*, &c. and by the *Romans* for *V*, as in *amabit* for *amavit*, *Berna* for *Verna*, &c. whence aroſe that jeſt of *Aurelian* on the Emperor *Boneſus*, *Non ut vivat natus eſt, ſed ut bibat.*

B requires an entire cloſure and preſſure of the lips to pronounce it, and therefore can ſcarce ever end the ſound of a word: But when you endeavour to pronounce it there, you are obliged to add an E to open the lips again; as in *Job*, which is ſounded *Jobe*.

C, is the third letter, or ſecond conſonant of the alphabet, and is formed from the κ of the *Greeks*, by retrenching the ſtem, or upright line.

All the Grammarians agree that the *Romans* pronounce their *q* like our *c*, and their *c* like our *k*: *F. Mabillon* adds, that *Charlemagne* was the firſt who wrote his name with a *C*; whereas all his predeceſſors of the ſame name wrote it with a *K*, and the ſame difference is obſerved in their coins.

D, the fourth letter of the alphabet, and the third conſonant, is generally ranked by the grammarians among the *lingual* letters, as ſuppoſing the *tongue* to have the principal ſhare in the pronunciation thereof.

The form of our *D* is the ſame with that of the *Latins*, and the Latin *D* is no other than the *Greek* Δ, rounded a little by making it quicker.

E, the fifth letter of the alphabet, and the ſecond vowel, admits of ſome variety in the pronunciation in moſt languages; whence grammarians uſually diſtinguiſh ſeveral *E*'s, or kinds of *E*. The *Greeks*, *e gr.* have their ſhort and long, *viz.* ε and η, *Epſilon* and *Eta*. The *Latins* have an opener *e*, called *vaſtius*, ſuch was the ſecond *e* in the word *here*, maſter; and another cloſer, as that in the adverb, *here*, yeſterday. This later *e* they frequently uſed promiſcuouſly with *i*; thus for *here* they wrote *heri*, and in divers places we meet with *ſibe*, *quaſe*, &c. for *ſibi*, *quaſi*, &c.

In *Engliſh* they eaſily diſtinguiſh three *E*'s, or ſounds of *E*; the firſt mute, and not heard at all, as in *Amſterdam*, *ſenſe*, *blue*, &c. the ſecond cloſe, or ſhort, pronounced with the Lips nearly ſhut; as in *equity*, *nettle*, &c. the third open or long, as in *fear*, *eaſe*, &c.

The *French* have, at leaſt, ſix kinds of *E*; the firſt pronounced like *a*, as in *emporter*, *orient*, &c. the ſecond a final mute, in the laſt Syllable of divers words not pronounced at all; as in *bonne*, *donne*, &c. the third an imperfect mute, pronounced much like the dipthong *ea*, as *je*, *de*, *te*; the fourth *e ferme*, or *e* maſculine, mark'd at the end of words with an *é*, as in *Jugé*, *Chaſtié*, &c. the fifth is *e ouvert*, or *long*, having the ſame ſound with *ai*, as in *Mere*, *Feſte*, &c. in the middle of words it is ſometimes marked with a circumflex, and in the end with an accent *é*: the ſixth is an intermediate *E* between the *ouvert* and *ferme*, as in *Cabaret*, *Lettre*, &c. Some add a ſeventh kind of *e*, not reducible to any of the former, as that in *grammarien*, *hiſtorien*, &c. and others admit of only of three kinds, *viz.* the *mute*, *open*, and *ſhut*: but they make variations therein, which amounts to the ſame thing.

As to the figure of the letter *E*, we borrow it from the *Latins*, who had it from the *Greeks*.

The little *e* was formed of the great one, by writing it faſt, and making the croſs ſtrokes at top and bottom without taking the pen off the paper, and then adding the ſtroke in the middle.

F, the ſixth letter of the alphabet, and the fourth conſonant, may be conſidered abſolutely, and in itſelf, or with regard to the particular Languages where it is found. In the firſt view, *f* is generally placed by ſome grammarians among the mutes, like the Φ among the *Greek* grammarians; though others give it the quality of a ſemivowel.

This letter is derived to us from the *Romans*, who borrowed it from the *Æolians*, which of conſequence, is no other than a corruption of the *Greek* Φ: yet the ſound was much ſofter among the *Latins* than among the *Greeks*; as was long ago obſerved by *Terentianus*.

It may be added that the pronunciation of the *f* is almoſt the ſame with that of the *v*; as will be evident by attending to the manner of pronouncing the following words, *favour*, *vanity*, *felicity*, *vice*, *foment*, *vogue*, &c. The *French*, particularly, in borrowing words from other languages, uſually

turn the final *v* into an *f*, as *Chetif*, of the *Italian Cattivo*; *Neuf*, of the *Latin Novus*; *Nef* of the *Latin Navis*, &c.

In the latter *Roman* writers we find the *Latin f* and *Greek* φ, *ph*, frequently confounded; as in *Falanx*, for *Phalanx*; *Filoſophia*, for *Philoſophia*, &c. which is ſtill retained by many *French* writers, who write *Filoſophie*, *Filippe*, *Epifane*, &c. and by the *Engliſh*, as in *Fantaſy*, *Filtre*, &c.

G, the ſeventh letter of our alphabet, and the fifth conſonant, is of the mute kind, and cannot be any way ſounded without the help of a vowel: it is formed by the reflection of the air againſt the palate, made by the tongue, as the air paſſes out of the throat. So that *G* is a palatal letter.

The *Latins* took the liberty to drop the letter *G* at the beginning of words before an *n*; as in *gnatus*, *gnoſco*, *gnobilis*, *gnarrat*, &c. which they ordinarily wrote *natus*, *noſco*, *nobilis*, *narrat*, &c. they alſo frequently changed it into *C*, as *Gamelus*, into *Camelus*; *Gragulus* into *Graculus*, &c. ſometimes it was put inſtead of *N* before a *C*, and another *G*; as *Agchiſes*, *Agora*, *Agguilla*, &c. for *Anchiſes*, *Anchora*, *Anguilla*, &c.

The northern people frequently change the *G* into *V* or *W*; as in *Gallus*, *Wallus*; *Gallia*, *Wallia*, *Vallia*, &c. for in this inſtance it muſt not be ſaid that the *French* have changed the *W* into *G*, by reaſon they wrote *Gallus* long before *Wallus*, or *Wallia* were known, as appears from all the antient *Roman* and *Greek* writers.

The form of our G is taken from that of the *Latins*, who borrow'd it from the *Greek* gamma Γ.

H, the eighth letter of the alphabet, and the ſixth conſonant. Some will only have it an *aſpiration* or *ſpirit*, becauſe its ſound is ſo weak.

But it is already ſhewn that the *h*, like all the other *aſpirates*, from the time it is aſpirated, and for this very reaſon that it is aſpirated, is not only a letter, but a *real conſonant*; it being a motion, or effort of the *larynx*, to modify the ſound of the vowel that follows; as is evident in the words *heaven*, *health*, *hero*, &c. where the vowel *e* is differently modified from what it is in the words *endive*, *eating*, *elect*, &c. and ſuch modification is all that is eſſential to a conſonant.

The *h* then is a letter, and a conſonant of the *guttural* kind, *i. e.* a conſonant, to the pronunciation whereof, the *throat* concurs in a particular manner, more than any other of the organs of voice.

When the *h* is preceded by *a c*, the two letters together have frequently the ſound of the *Hebrew* ש, with a point over the right horn, as in *charity*, *chyle*, &c.

The aſpirate, or ſharp accent of the *Greeks*, which is the ſame with our *h*, is frequently changed for an *f*, as ἅλς, *ſal*; ἑπτὰ *ſeptem*, &c.

I, the ninth letter of the *Engliſh* alphabet, is both a vowel and a conſonant, agreeable to which two different powers, it has two different forms.

The *Hebrews* called the *j* conſonant *jod*, יוֹד, from יָד, *hand* and *ſpace*; becauſe it is ſuppoſed to repreſent the hand clenched, ſo as to leave the ſpace underneath void. With them it was pronounced as the conſonant *y*, as it ſtill is among the *Germans*, and ſome other people. The *Greeks* had no *j* conſonant, and for that reaſon uſed their vowel *i* inſtead of it, as coming the neareſt in ſound. The *French* and *Engliſh* have two kinds of *j* conſonants, the firſt has a ſnuffling kind of ſound, and ſerves to modify that of the vowels, pretty much like *g*; as in *Jew*, *juſt*, *jovial*; the latter is pronounced like the *Hebrew* jod; inſtances of which we have in ſome of our words, which are indifferently wrote with a *y* or an *i* before a vowel, as *voiage*, *voyage*, *loial*, *loyal*, &c. in which caſes the *i* is apparently a conſonant, as being a motion of the palate, which gives a modification to the following vowel.

The vowel *i*, according to *Plato*, is proper for expreſſing fine and delicate, but humble things, on which account that verſe in *Virgil*,

Accipiunt inimicum imbrem, rimiſque fatiſcunt.

which abounds in *i*'s, is generally admired.

K, a double conſonant, and the tenth letter of the alphabet, is borrowed from the *Greek* Kappa, and was but little uſed among the *Latins*: we ſeldom find it in any *Latin* author, except in the word *Kalendæ*, where it ſometimes ſtands in lieu of a *c*.

In the *Engliſh* the *k* is uſed much more than need be, particularly at the ends of words, after *c*, as in *publick*, *phyſick*, where it is of no manner of ſervice.

L, a ſemi-vowel or liquid, makes the eleventh letter of the alphabet. It has a ſweet ſound, and is pronounced by applying the *tongue* to the *palate*.

The *Spaniards* and *Welch* uſually double the *l* at the beginning of a word, which ſounds nearly the ſame with the *Engliſh hl*, or *ſl*.

The figure of our *l* we borrow from the *Latins*, they from the *Greeks*.

M, a liquid conſonant, and the twelfth letter in the alphabet, is pronounced by ſtriking the upper lip againſt the lower.

Quintilian obſerves, that the *Greeks* always change *m*, at the end of a word, into *n*, for the ſake of the better ſound.

N,

N, a liquid conſonant, and the thirteenth letter of the *Greek*, *Latin*, *French*, *Engliſh*, &c. Alphabets, ſounds like a *d*, paſſed through the noſe. The Abbot *Dangeau* obſerves, that in the *French* the *n* is frequently a mere naſal vowel, without any thing of the ſound of a conſonant in it; he calls it the Sclavonick vowel.

N before *p*, *b*, and *m*, the *Latins* change into *m*, and frequently into *l* and *r*, as *in-ludo*, *illudo*; *in-rigo*, *irrigo*, &c. The *Greeks* alſo, before κ, γ, χ, ξ, changed the ν into γ; in which they were followed by the antient *Romans*; who for *Angulus*, wrote *Aggulus*, &c.

O is the fourteenth letter of the alphabet, and the fourth vowel. The *grammarians* call it a cloſe vowel, becauſe pronounced with the mouth ſhut.

Among the *Latins*, the *o* bore ſo great an affinity with the *u*, that they frequently confound them; writing *conſol*, and pronouncing *conſul*.

The *Greeks* had two *o*'s, *viz.* Omicron ο, and Omega, ω; the firſt pronounced on the tip of the lips with a ſharp ſound, the ſecond in the middle of the mouth with a full ſound, equal to *oo* in *Engliſh*. The long and ſhort pronunciation of the *Engliſh o*, are an equivalent to the two *Greek* ones; the firſt as in ſuppoſe, the ſecond as in *o*bey.

P, is a conſonant, and the fifteenth letter in the *Engliſh* alphabet. When the *P* is followed with an *h*, in the ſame word, it has the ſound of an *F*; thus *philoſophy* is pronounced *filoſophy*.

Q, a conſonant, and the ſixteenth letter of the alphabet, is always followed by an *u*,

The Q is formed from the *Hebraw* ק, *Caph*; which moſt other languages have borrow'd.

In effect, there is that reſemblance between the Q and C in ſome languages, and K in others, that many grammarians, in imitation of the *Greeks*, baniſh the Q as a ſuperfluous letter.

In the *French*, the ſound of the *q* and *k* are ſo near akin, that ſome of their niceſt authors think the former might be ſpared.

Some very learned men make *q* a double letter, as well as *k* and *x*. According to them, *q* is evidently a *c* and *u* joined together. It is not enough that the ſound is the ſame, but they ſee the traces of *c u* in the figure of Q; the V being only laid obliquely, ſo as to come within the cavity of the C, as C ⋖.

R, is a liquid conſonant, and the ſeventeenth letter of the alphabet. The grammarians hold it a ſemi-vowel, eſpecially in the *Greek*, where, in common with the other vowels, it admits an aſpirate, *&c.* tho' whether the aſpirate ſhould be ſounded before or after it, is ſome doubt.

The *Hebrews* allow the *r* the privilege of a *guttural*, that is, they never double it.

In the *French* the *r* is never pronounced at the end of a word, unleſs it be immediately before a vowel, *e. gr. aimer ſon roy*, that *r* in *aimer* is not ſounded, and the word is pronounced as if there was none, and as if it was wrote *aimé ſon roy*: on the contrary, in *aimer a boire*, the *r* is pronounced, becauſe immediately before a vowel; but then the pronunciation of the *r* muſt be very ſoft, as if the tongue ſhould paſs ſlightly over it, to lay the whole ſtreſs on the *a*.

S, a conſonant, and the eighteenth letter of the alphabet; is accounted one of the three hiſſing conſonants, the other two, being *z* and *j*. It is alſo held a ſemi-vowel, as forming a kind of imperfect ſound, without the aſſiſtance of any vowels.

Of all others, the *ſ* is neareſt a kin to the *r*; hence it was frequently changed, by reaſon of its diſagreeable ſound into *r*.

The old and the new orthography of the *French*, differ chiefly on the uſe of the *ſ*: the latter omitting it in writing, where it is not heard in the pronunciation, and the former retaining it. Thus the followers of the one, particularly the academy, in their dictionary, write *tempeſte*, *huiſtre*, *fluſte*; thoſe of the other, *tempête*, *huître*, *flûte*, &c. In the ſame language, *s* is never pronounced, or ſounded at the end of a word, unleſs, like the *r* it be immediately before a vowel; as, *javois chanté*, *s* in *javois*, is not ſounded before *chanté* and the word is pronounced as if there was no *s*, viz. *javoi chanté*; but it is not the ſame in *javois aimé*, where the *s* is pronounced, as if it was wrote *javoi ſaimé*.

T, a conſonant, and the nineteenth letter in the alphabet, in ſound, bears a reſemblance to the *d*, for which reaſon they are often put for each other.

The *t* is one of the five conſonants, which the Abbot *Dangeau* calls palatal, and which are *d*, *t*, *g*, *k*, and *n*: the four firſt whereof have the ſame relation to each other, as the labial *b*, *p*, and *v*, *f*, have. *D*, for inſtance, having the ſame relation to *t*, that *b* has to *p*, or *v* to *f*.

U, is the fifth vowel, and the twentieth letter in the alphabet. Beſides the vowel *u*, there is a conſonant of the ſame denomination, wrote *v*, or V.

The pronunciation of the *u*, as now uſed among the *Engliſh*, *French*, &c. is borrow'd from the antient *Gauliſh*; for all the other weſtern people, with the *Romans*, pronounce it *ou*.

W, is a letter particular to the northern languages and people, as the *Engliſh*, *Dutch*, *Poliſh*, and others of *Teutonick* and *Sclavonick* original, and admitted into the *French*, *Italian*, &c in proper names, and other terms, borrowed from the languages where it is uſed.

In *Engliſh*, the *w* is uſually a conſonant, and as ſuch may go before all the vowels, except in *u*: as

in *want*, *weapon*, *winter*, *world*, &c.

It is ſometimes alſo a vowel, and as ſuch follows any of the vowels, *a*, *e*, *o*, and unites with them into a kind of treble vowel, or tripthong; as in *law*, *ewe*, *ſow*, &c.

X, is a double conſonant, and the twenty-ſecond letter of the *Engliſh* alphabet.

The *x* of the *Latins*, and ξ of the *Greeks*, are compoſed of *c s*, and *x σ*; whence to this day the letter *x*, in the *Engliſh* and *French*, has the ſame ſound with *c ſ*, or *k ſ*. Thus we pronounce *Alexander*, as if wrote *Alexſander* or *Alakſander*.

The *Italians* have no *x* at all in their language, but both ſpeak and write *Aleſſandro*. The *Spaniards* pronounce the *x* like the *Engliſh c* before *a*; viz. *Alexandro*, as if it were *Alecandro*. The *Portugueſe* pronounce it like *ſh*, as *muxo* is pronounced *muſho*.

In foreign words uſed in *Engliſh*, they ſometimes ſoften the *x* into a double *ſſ*; as *Bruſſels*, for *Bruxelles*, &c.

This letter is not known in the *Hebrew*, or other oriental languages; but in lieu of it, they write the two ſimple letters, whereof it is compounded, and the like do the modern *Germans*.

Y is the twenty-third letter in the *Engliſh* alphabet, borrowed originally from the *Greek υ*.

It is occaſionally both *vowel* and *conſonant*. As a *vowel*, ſome authors have judged it unneceſſary in *Engliſh*, in regard its ſound is preciſely the ſame with that of the *i*. Accordingly it is but little uſed, except in words borrow'd from the *Greek*, to denote their origin, by repreſenting the *Greek* υ.

The vowel *y* has a place in ſome words purely in *Engliſh*, and that both in the middle thereof, as in *dying*, *frying*, &c. and at the end as in *lay*, &c.

Z is the laſt letter in the alphabet, and one of the double conſonants, both among the *Latins* and *Greeks*. The ſound was not always the ſame as it is now, which is but as it were half that of an S.

All the *letters* of the alphabet, heretofore mentioned, were alſo *numeral characters* among the antients, *viz.*

A ſignified 500, with a daſh a-top $\overline{A}$ it ſtood for 5000. This uſage was introduced in the days of barbariſm.

$\overline{B}$ ſtood for 3000; with a kind of accent below it ſtood for 200: but among the *Greeks* as well as *Hebrews*, this letter ſignified only two.

C, among the *Romans*, ſignified 100.

D ſignified 500; $\overline{D}$ denotes 5000.

E ſignified 250.

F ſignified 40.

G ſignified 400; $\overline{G}$ ſignified 40,000.

H ſignified 200; $\overline{H}$ ſignified 200,000.

I, in the ordinary *Roman* way of numbering, ſignifies one; and when repeated, ſignifies as many units as it is repeated times. 1. c. 100.

K ſignified 250; $\overline{K}$ ſtood for 250,000.

L ſignified 50; $\overline{L}$ ſtood for 50,000.

M ſignified 1000; $\overline{M}$ ſignifies a thouſand times a thouſand.

N ſignified 900; $\overline{N}$ ſtood for 9000.

O ſignified 11; $\overline{O}$ ſignified 11,000.

P ſignified the ſame with G, *viz.* 400, though *Baronius* thinks it rather ſtood for ſeven: $\overline{P}$ ſtood for 400,000.

Q ſignified 500: $\overline{Q}$ denoted 500,000.

R ſignified 80: $\overline{R}$ ſignified 80,000.

S ſignified ſeven.

T ſignified 160: $\overline{T}$ ſignified 160,000.

V ſignifies five: $\overline{V}$ ſignified 5000.

X denotes 10.

Y ſignified 150, or according to *Baronius* 159; $\overline{Y}$ ſignified 150,000.

Z ſignified 2000: $\overline{Z}$ ſignified two thouſand times two thouſand.

The numeral characters, now chiefly in uſe, are the *common* and the *Roman*; to which may be added the *Greek*.

Common characters, are thoſe ordinarily called the *Arabick*, as ſuppoſed to have been invented by the *Arabick* aſtronomers; though the *Arabs* themſelves call them the *Indian* characters, as if they had borrowed them from the people of *India*. The *Arabick* characters are ten, *viz.* 1, 2. 3, 4, 5, 6, 7, 8, 9, 0, the laſt called a cypher.

The *Roman character*, conſiſts of the majuſcule letter of the *Roman* alphabet.

The numeral letters, that compoſe the *Roman characters*, are ſeven, *viz*, I, V, X, L, C, D, M. The I denotes one, V five, X ten, L fifty, C hundred, D five hundred, M a thouſand. The I repeated twice makes two, II; thrice, three III; four is expreſſed thus IV; I before V or X taking an unit from the number expreſſed by each of thoſe letters. To expreſs ſix, an I is added to a V, VI: for ſeven, two, VII: and for eight, three, VIII: nine is expreſſed by an I before X, IX, agreeable to the preceding remark. The like remark may be made of the X before L or C, except that the diminution is by tens, not units, thus XL ſignifies forty, and XC ninety: and L followed with an X ſixty, LX, &c. The C before D or M, diminiſhes each by a hundred. Beſides the letter D which expreſſes five hundred, that number may alſo be expreſſed, by an I before a C inverted, thus IↃ, and thus in lieu of the M, which ſignifies a thouſand, is ſometimes uſed an I between two C's, the one erect, the other inverted, thus CIↃ: agreeable to this ſix hundred may be expreſſed IↃC, and ſeven hundred IↃCC, &c.

The *Greeks* had three ways of expreſſing numbers, the moſt ſimple was for every ſingle letter, according to its place in the alphabet, to denote a number from α 1, to ω 24, in which manner the books of *Homer*'s *Iliads* are diſtinguiſhed. Another way was by dividing the alphabet into 8 units; α 1, β 2, &c. tens; ι 12, κ 20, &c. Hundreds; ϱ 100, σ 200. Thouſands they expreſſed by a point, or accent under a letter. *e. gr.* α 1000, ϛ 2000, &c. A third way was by ſix capital letters, thus I (ια for μία) 1, Π (πεντε) 5, Δ (δεκα) 10, H (Ηεκατον) 100, X (χίλια) 1000, M (μυρία) 10000.

The *Hebrew* alphabet was divided into 9 units: א 1, ב 2, &c. — 9 tens: י 10, כ 20, &c. 9 hundreds; ק 100, ר 200, &c. ך 500, ם 600, ן 700, ף 800, ץ 900. — Thouſands were ſometimes expreſſed by units prefix'd to hundreds, as, אלרד, 1534, &c.

From the doctrine of *letters* and *characters*, we'll proceed to *Syllables*. A ſyllable is part of a word, conſiſting of one or more letters, which are pronounced together; or a compleat ſound, uttered in one breath, conſiſting either of a vowel alone, or of a vowel and one or more conſonants: or, according to *Scaliger*, a *ſyllable* is an element under one tone or accent, that is, which can be pronounced at once: or, according to *Priſcian*, a comprehenſion of ſeveral letters falling under one accent, and produced at one motion of the breath: or, a literal or articulate voice of an individual ſound.

In every word, therefore, there are as many *ſyllables* as there are *vocal ſounds*, and as many vocal ſounds, as there are ſimple, or compound *vowels*; each whereof requires a diſtinct motion of the *pectoral* muſcles. Thus *a*, *a*, *a*, make three *ſyllables*, formed by ſo many motions, diſtinguiſhed by ſmall ſtops between each expiration.

From the number of *ſyllables* in words, they are denominated *monoſyllables*, *biſyllables*, *triſyllables*, *polyſyllables*, q d. words of one *ſyllable*, *two ſyllables*, *three ſyllables*, and many *ſyllables*.

WORDS are diſtinct articulate ſounds agreed on by mankind, to convey their thoughts and ſentiments.

Words, as obſerved, are divided into *monoſyllables*, *biſyllables*, &c.

Monoſyllables are words of a *ſingle ſyllable*, or which conſiſt of one or more letters pronounced together.

Words, again, are divided into *primitives* and *derivatives*, *ſimple* and *compound*, *ſynonymous* and *equivocal*.

Primitive, is a *root*, or a word in a language, which is neither derived from any other language, nor compounded from any other word of the ſame. Thus *God* is a *primitive*, *godly* a *derivative*, *god-like* a *compound*.

Derivative is a word which takes its origin from another word, called its *primitive*. *Manhood*, *deity*, *lawyer*, &c. are derived from *man*, *deus*, *law*, &c.

Equivocal is a word or expreſſion, that is dubious, and ambiguous; or that may have ſeveral ſenſes, one true and another falſe. — Such is the word *emperor*, which is both the name of a dignity, the proper name of a perſon, and the name of a plant.

In theſe caſes one word denotes divers conceptions, and divers things.

Synonymous is a word that has the ſame import, or ſignification with another.

The moſt celebrated Grammarians divide words into *eight claſſes*, called *parts of ſpeech*; which are *Noun*, *Pronoun*, *Verb*, *Participle*, *Adverb*, *Conjunction*, *Prepoſition*, and *Interjection*; to one or other of which, all the words, and turns in all languages, which have, or may be invented to expreſs our ideas, are reducible.

NOUN is the name or word, which expreſſes the ſubject ſpoke of; or expreſſes a ſubject, whereof ſomething is, or may be affirmed; as *man*, *food*, *whiteneſs*, *Henry*, &c. A *Noun*, therefore, in language, anſwers to an idea in Logick.

Nouns, again, are divided into *Nouns Subſtantive*, and *Nouns Adjective*.

They are called *Subſtantives*, when the objects, they deſign, are conſider'd ſimply in themſelves, and without any regard to their qualities.

They are called *Adjectives*, when their objects are conſidered as cloath'd with any qualities. Thus, when I ſay ſimply, the *Heart*, in *Engliſh*, the word *Heart*, is called a *Noun Subſtantive*, inaſmuch as it does not expreſs any of its qualities; but if I ſay in *Engliſh*, *the generous Heart*, I then conſider the *Heart*, accompanied with the quality of *generous*. For this reaſon, the word *generous* is called a *Noun Adjective*; becauſe it adds a quality to the object.

Nouns are again divided into *proper* and *appellative*. *Nouns proper* are thoſe, which expreſs a *particular* thing or perſon, ſo as to diſtinguiſh it from all other things of the ſame kind, as *Socrates*, *Peter*, *Paul*, *James*, &c. *Nouns appellative* are thoſe common to *ſeveral* individuals, of the ſame kind, as *Man*, *Angel*, &c.

There are alſo heterogeneous Nouns, which are ſuch as are of one gender in the ſingular number, and of another in the plural. Theſe Nouns are alſo called *Heteroclite*, of which we have

various ſorts, *viz.* *defective* and *redundant Heteroclites*, &c. Under the claſs of *Heteroclites* come *Aptotes*, *Diptotes*, *Monaptotes*, *Triptotes*, *Tetraptotes*, *Pentaptotes*, &c.

Aptote is a noun without any variation of caſe; as, *fas nihil*, &c.

Diptote has only two caſes; as, *Nom. fors*, *Abl. forte.*

Triptotes have only three caſes; ſuch is *dica*, *dicas*, *dicam.*

Tetraptote have only four caſes, as *repetundæ*, &c.

Pentaptote has only five caſes.

PRONOUN is a part of ſpeech, uſed in lieu of noun, or name; whence the denomination from *pro* and *nomen*, q. d. for *noun* or *name.*

As it would have been diſagreeable to have been always repeating the ſame name, there are words invented in all languages, called *Pronouns*, to ſave the neceſſity thereof, and to ſtand in the place of names; as in *Engliſh*, I, thou, he.

They are called *Pronouns*, becauſe uſed in the place of particular *Nouns.*

The *grammarians* ordinarily diſtinguiſh *Pronouns* into four claſſes, with regard to their different ſignification, formation, *&c.* viz. *Pronouns perſonal*, *relative*, *poſſeſſive*, and *demonſtrative*, to which may be added, *indeterminate Pronouns.*

Perſonal Pronouns are thoſe uſed in lieu of names of particular perſons; ſuch are *I*, *thou*, *he*, *we*, *ye*, *they*; or in *French*, *moy*, *toy*, *luy*, *nous*, *vous*, *eux.*

Pronouns relative are thoſe placed after *Nouns*, with which they have ſuch affinity, that without them they ſignify nothing, ſuch are *who*, *that*; or in *French*, *qui*, *cela*, &c.

Pronouns poſſeſſive are thoſe, which expreſs what each poſſeſſes, or what belongs to him, as *mine*, *thine*, *his*; or in *French*, *mien*, *tien*, *ſiene*, &c. Theſe are pure Adjectives, and only differ from the reſt by the relation they bear to *Pronouns*, whence they are derived, and by ſome particular inflections, which they have in ſome languages.

Pronouns demonſtrative are thoſe, which ſerve to indicate or point out the ſubject ſpoken of; as *this*, *thoſe*; or in *French*, *cecy*, *cela*, *ceuxla*, or *celles la*, &c.

Pronouns indefinite are thoſe, which expreſs their ſubject indeterminately; as *however*, *any*, &c.

Pronouns are likewiſe divided into *Subſtantive* and *Adjective.* To the firſt belong *I*, *thou*, *he*; to the ſecond, *my*, *mine*, *who*, *what*, &c.

Pronouns may alſo be conſider'd in two ſtates; the firſt or foregoing ſtate, as *I*, *we*; the ſecond or following one, as *me*, *us.*

It has been thought proper, in order to render diſcourſe more expreſs and diſtinct, as alſo to embelliſh it by a variety of terminations, to contrive certain diverſities in Adjectives, accommodated to the Subſtantives they are applied to: whence from a regard to that notable difference there is between the two ſexes, all Nouns Subſtantive have been diſtinguiſhed, in *maſculine* and *feminine genders*; and the Nouns Adjective alſo varied to correſpond therewith.

But as there was an infinity of words, which had no proper relation, either to the one ſex or the other, they had *genders* aſſigned them, rather out of caprice than reaſon; and hence it is that the *gender* of a Noun, is frequently dubious and fluctuating.

This inſtitution of *genders* was introduced by cuſtom and uſage. At firſt there was only a difference between the names of animals, when ſpoke of males and females; by degrees the ſame regulation was extended to other things: the Grammarians have only noted and allowed what uſage had eſtabliſhed.

The oriental languages frequently neglect the uſe of *genders*; and the *Perſian* language has none at all. The *Latins*, *Greeks*, &c. generally content themſelves to expreſs the different *genders* by different terminations; as *bonus equus*, a good horſe; *bona equa*, a good mare; but in *Engliſh* they go farther, and expreſs the difference of ſex, by different words; as boar, ſow; boy, girl; buck, doe; bull, cow; cock, hen; dog, bitch, *&c.* The *French* follow in ſome things the practice of the *Latins*, and in others that of the *Engliſh.* For they ſometimes expreſs the difference of genders, by different terminations; as *aſne*, *aſneſſe*; *chien*, *chiene*; *chat*, *chatte*, &c. and ſometimes by different words; as *gargon*, *fille*: *toreau*, *vache*; *cerf*, *biche*, &c.

The *Engliſh* have only about twenty-four feminines, diſtinguiſhed from the males, by the variation of the termination of the male into *eſs*; of which number are abbot, abbeſs; count, counteſs; actor, actreſs; heir, heireſs; prince, princeſs, *&c.* which is all the *Engliſh* know of any thing like *genders.*

The eaſtern languages, as well as the vulgar ones of the weſt, have only two *genders*; the maſculine and feminine. The *Greeks* and *Latins* have likewiſe the *neuter*, *common*, and the *doubtful gender*; and beſides theſe, they have the *epicene* or promiſcuous, which under one ſingle *gender* or termination, includes both the kinds.

The *Maſculine* GENDER, is that which belongs to the male kind, or ſomething analogous to it.

The *Feminine* GENDER is that which denotes the noun or name to belong to a female.

The *Neuter* is a ſort of gender of nouns, which are neither maſculine nor feminine. In *Engliſh*, and other modern languages, there is no ſuch thing as Neuter Nouns.

Epicene is a term applied to Nouns, which under the ſame *gender* and termination, mark indifferently two kinds or ſexes; ſuch in *Latin* is *aquila*, *veſpertilio*, &c. which ſignify equally a male or female eagle, or bat.

Grammarians diſtinguiſh between *Epicene* and *Common*.——A Noun is ſaid to be common of two kinds, when it may be joined either with a maſculine or a feminine article; and *Epicene*, when it is always joined to ſome one of the two articles, and yet ſignifies both *genders*.

The Inflection of a Noun, according to its different caſes, is called Declension, which is a different thing in the modern languages, which have not properly any caſes, from what it is in the antient *Greek* and *Latin* which have.

Declenſion in languages, wherein the Nouns admit of changes, whether in the beginning, middle, or end, is properly the expreſſing or reciting of all thoſe changes in a certain order, and by certain degrees, called *caſes*.

In languages wherein the Nouns do not admit of changes, *declenſion* is the expreſſing of the different ſtates or habitudes a Noun is in, and the different relations it has; which difference of relation is mark'd by particles, called *articles*, as *a*, *the*, *to*, *from*, &c. and in *French* (in the ſingular number) *le*, *la*, *du*, *ó*, *au*, or *à*, *le*; and in the plural number, *les*, *des*, *aux*, *les*, &c.

Every declenſion has commonly two *numbers*, *viz.* the *ſingular* and the *plural*; which numbers are a modification of Nouns, *&c.* to accommodate them to the varieties in their objects, conſider'd with regard to number.

When a Noun indicates an object, conſider'd as ſingle or alone, or a number of them conſider'd as united together, it is ſaid to be of the ſingular number; as a *tree*, a *troop*, a *temple*, &c. or in *French*, *un homme*, *un fille*, *un temple*, &c.

When it indicates ſeveral objects, and thoſe as diſtinct, it is of the plural number; as *temples*, *trees*, &c. or in *French*, *hommes*, *filles*, &c. Thus when I ſpeak of myſelf, as making part of ſeveral others, inſtead of *I*, I ſay *we*, in *French*, *nous*, &c.

The *Greeks* have a third number, which they call the *dual number*, as ſignifying two. The *Hebrews* have ſomething like it, but then it only takes place when the words ſignify a thing double by nature, as the hands, the eyes, *&c.* or by art, as ſciſſars, tongs, *&c.*

As to common and appellative names, they ſeem all naturally to require a plural number; yet there are ſeveral which have none, as the names of *gold*, *ſteel*, &c.

The difference of numbers in Nouns, is expreſs'd by a difference of *termination* or *ending*.

In *Engliſh* and *French*, the ſingular is uſually converted into plural, by adding *s*; as *tree*, *trees*, *hand*, *hands*; and in *French*, *arbre*, *arbres*, *main*, *mains*, &c. where the pronunciation requires it in *Engliſh*, as when the ſingular ends in *s* or *x*, *ſh* or *ch*, it is uſually done by the addition of *es*, inſtead of *s*.

The plurals of Adjectives, though varied from the ſingulars in moſt other languages, yet in *Engliſh* are generally the ſame.

Every number has commonly *ſix caſes*, or different inflections, or terminations of nouns; ſerving to expreſs the different ſtates or relations they bear to each other, and to the things they repreſent.

They are called *Nominative*, *Genitive*, *Dative*, *Accuſative*, *Vocative*, and *Ablative*.

Though ſeveral of theſe caſes be frequently alike, as the Gentive and Dative ſingular, of the firſt declenſion of the *Latin*; the Dative and Ablative plural of the ſecond, *&c.* the Genitive and Dative dual of the *Greek*, &c. ſo that the termination is not the ſole criterion of the caſe.

The ſimple poſition, or laying down of a noun or name, which is declinable, is called the *Nomitive caſe*, yet it is not ſo properly a caſe, as the matter, or ground whence the other caſes are to be form'd, by the ſeveral changes and inflections given to this firſt termination. Its chief uſe is to be placed in diſcourſe before all verbs, as the ſubjects of the propoſition or affirmation, as *dominus regit me*, the Lord governs me; *Deus exaudit me*, God hears me.

The relation of one thing, conſider'd as belonging in ſome manner to another, has occaſioned a peculiar termination of nouns, called the *Genitive caſe*.

In *Engliſh*, the *genitive caſe* is made by prefixing the particle *of*; in *French*, *de*, or *du*, &c.

The *Dative* expreſſes the ſtate or relation of a thing, to whoſe profit or loſs ſome other thing is referr'd. It is called *Dative*, becauſe uſually govern'd by a verb implying ſomething to be *given* to ſome perſon; as *commodare Socrati*, to lend to *Socrates*.

In *Engliſh* this relation is expreſſed by the ſign *to* or *for*; and in *French*, by the ſign *a*, or *au*.

The *Accuſative* is the fourth caſe of nouns, that are declin'd. Its uſe may be conceived from this, that all verbs, which expreſs actions, that paſs from the agent, as to *beat*, &c. muſt have ſubjects

to receive thoſe actions; for, if I *beat*, I muſt beat ſomething; ſo that ſuch Verb, evidently requires after it a Noun or name, to be the object of the action expreſſed. Hence in all languages, which have caſes, the Nouns have a termination, which they call *Accuſative*; as, *amo Deum*, I love God.

In *Engliſh* and *French*, they have nothing to diſtinguiſh this caſe from the *Nominative*; but as they ordinarily place words in their natural order, it is eaſily diſcovered; the *Nominative* conſtantly preceding, and the *Accuſative* following the Verb. Thus when we ſay that *John* loves *Jane*, and *Jane* loves *John*; *John* is the *Nominative* in the firſt, and the *Accuſative* in the laſt; and *Jane* is the *Accuſative* in the firſt, and the *Nominative* in the laſt.

The *Vocative* is the fifth caſe, or ſtate of Nouns. When we name the perſon we are ſpeaking to, or addreſs ourſelves to the thing we are ſpeaking of, as if it were a perſon, the Noun or name requires a new relation, which the *Latins* and *Greeks* expreſs by a new termination, called *Vocative*. Thus of *Dominus*, Lord, in the *Nominative*, the *Latins* have made *Domine*, O Lord, in the *Vocative*; of *Antonius*, *Antonii*, &c. But as this was a thing not abſolutely neceſſary, and as the *Nominative caſe* might ſerve on ſuch occaſions, this new caſe or termination, was not univerſal in the plural; for inſtance, it was the ſame with the *Nominative*; even in the ſingular, it was only practiſed in the ſecond declenſion among the *Latins*; and in *Greek* where it is the moſt common, it is frequently neglected, and the *Nominative* uſed inſtead of it; as in that paſſage in the *Greek* Pſalms, quoted by St. *Paul*, to prove the divinity of *Jeſus Chriſt*, Θρονος σου ὁ Θεος, thy throne O God!

In *Engliſh*, and moſt of the modern tongues, this caſe is ordinarily expreſſed in Nouns, that have an article in the *Nominative*, by ſuppreſſing that article; as, *The Lord is my hope. Lord, thou art my hope!* Though on many occaſions we uſe an Interjection.

The *Ablative* is the ſixth caſe of *Latin* Nouns. The *Ablative* is oppoſite to the *Dative*; the firſt expreſſing the action of *taking away*, and the latter that of *giving*.

In *Engliſh*, *French*, &c. there is no preciſe mark, whereby to diſtinguiſh the *Ablative* from other caſes; and we only uſe the term in analogy to the *Latin*. Thus in the two phraſes, *the magnitude of the city*, *and he ſpoke much of the city*; we ſay, that *of the city*, in the firſt is *Genitive*, and in the latter *Ablative*; becauſe it would be ſo, if the two phraſes were expreſſed in *Latin*.

VERBS are thus called of the *Latins*, *verbum*, word, by way of eminence; the Verb being the principal word of a ſentence.

The common definition given by grammarians, is, that a *Verb* is a word that betokens *being*, *doing*, or *ſuffering*.

To conceive the origin and office of Verbs, it may be obſerved, that the judgment we make of any thing, as when I ſay, *the earth is round*, neceſſarily includes three terms. The firſt called the *ſubject*, is the thing we affirm of, *e. gr. earth*. The ſecond called *attribute*, is the thing affirmed, *e. gr. round*. The third, *is*, connects thoſe two terms together, and expreſſes the action of the mind, *affirming* the attribute of the ſubject.

This laſt is what we properly call *Verb*. Its principal uſe is to ſhew the diſcourſe, wherein that word is uſed, is the diſcourſe of a man, who does not only conceive things, but judges and affirms ſomewhat of them.

Verbs are variouſly divided: with reſpect to the ſubject they are divided into *active*, *paſſive*, *neuter*, &c. With reſpect to their inflections, into *regular*, and *irregular*; *perſonal*, and *imperſonal*, *auxiliary*, *ſubſtantive*, &c.

VERB *active* is a *Verb*, which expreſſes an action, that falls on another ſubject, or object. Such are, *I love*, *I work*, &c. which ſignify the action of *loving*, *working*, &c.—Of theſe Grammarians make three kinds; the one called *tranſitive*, where the action paſſes on a ſubject different from the agent;—*reflected*, where the action returns upon the agent —*reciprocal*, where the action returns mutually upon the two agents that produce it.

VERB *paſſive* is that, which expreſſes a paſſion, or which receives the action of ſome agent, and which is conjugated in the modern tongues with the *auxiliary Verb*, *I am*, *je ſuis*, &c.

VERB *neuter* is that, which ſignifies an action, that has no particular object whereon to fall; but which, of itſelf, takes up the whole Idea of the action;—as, *I ſleep*, *thou yawneſt*, *he ſnores*, *we walk*, *you run*, *they ſtand*.—The *Latins* call them *neuters*, by reaſon they are neither *active* nor *paſſive*; though they have the force and ſignification of both: as *I languiſh*, ſignifies as much as to ſay *I am languiſhing*; *I obey*, as much as *I exerciſe obedience*, &c. only that they have no regimen to particularize this ſignification.

Of theſe *Verbs* there are ſome, which form their tenſes by the *auxiliary Verb*, *to have*; as, *I have ſlept*, *you have run*.—Grammarians call theſe *Neuters active*.

Others there are, which form their compound parts by the auxiliary, *to be*; as *to come*, *to arrive*, &c. for we ſay *I am come*, not *I have come*; in *French*, *Je ſuis venu*, not *Jai venu*, &c. Theſe are are called *Neuters paſſive*.

A Verb *ſubſtantive* is that, which expreſſes the being, or ſubſtance, which the mind forms to itſelf, or ſuppoſes in the object; whether it be there or not; as, *I am, thou art*; in *French*, *Je ſuis, tu es.*

Auxiliary, or *helping Verbs*, are thoſe, which ſerve in conjugating *active* and *paſſive Verbs*; ſuch are, *I am, I have*, &c.

Verbs in the *Engliſh*, and moſt modern tongues, do not change their endings, as in *Latin*, to denote the ſeveral times, modes, *&c.* of their being, doing, or ſuffering; but in lieu thereof, make uſe of auxiliaries: as, *have, am, be, do, will, ſhall, may, can*, &c.

Regular Verbs are thoſe, which are conjugated after ſome one manner, rule, or analogy.

Irregular, or *anamolous* Verbs are thoſe, which have ſomething ſingular in the terminations, or formation of their Tenſes.

The irregularity in *Engliſh* Verbs lies wholly in the formation of the preter Tenſe, and paſſive Participle.—The firſt, and moſt general irregularity, took its riſe from the quickneſs of our pronunciation, by changing the conſonant *d* into *t*; the vowel *e*, in the regular ending *ed*, being cut off, that the pronunciation might be more ready: thus for *dwelled, keeped, ſended*, we ſay *dwelt, kept, ſent.*

Verbs *impersonal* are thoſe, which have only the third perſon, as it behoves, *&c.*

As the Nouns are declined, the *Verbs* are conjugated: and what is called *Declenſion*, with regard to Nouns, *&c.* is called *Conjugation* with regard to *Verbs.*

Conjugation is an orderly diſtribution of the ſeveral parts or inflexions of *Verbs*, in their different Moods and Tenſes, to diſtinguiſh them from each other.

The *Latins* have four *Conjugations*, diſtinguiſhed by the terminations of their Infinitive, *āre, ĕre, ēre, īre*; and moſt of the *French* grammarians reduce the *Conjugations* of their language to the ſame number, ending in *er, re, ir*, and *oir.*

In *Engliſh*, where the Verbs have ſcarce any natural inflections, but derive all their variations from additional Particles, Pronouns, *&c.* we have hardly any ſuch things as ſtrict *Conjugations.*

Conjugations conſiſt of *Moods, Tenſes, Perſons*, and *Numbers.*

Mood, or Mode is uſed to ſignify the different manners of conjugating Verbs, agreeably to the different actions, or affections to be expreſſed; as *ſhewing, commanding, wiſhing*, &c.

Hence ariſe five *Moods*, viz. the *Indicative, Imperative, Optative, Subjunctive*, and *Infinitive.*

Some Grammarians reckon but four *Moods*, confounding the *Optative* with the *Subjunctive*, and ſome make *ſix*, dividing the *Optative* into *Potential*, and *Optative.*

The *Greeks* have five *Moods* of Verbs differing in termination; but the *Latins* have but four.—In *Engliſh*, the terminations are the ſame in all the *Moods.*

The *Indicative* is the firſt *Mood*, or manner of conjugating Verbs, ſhewing either the time preſent, paſt, or future.

The *Imperative* is the *Mood*, or manner of conjugating a Verb, ſerving to expreſs a commandment, as *go, come*; or in *French*, *alles, venes*, &c.

The *Optative* is the third *Mood*, in the conjugation of Verbs, ſerving to expreſs an ardent deſire, or wiſh for any thing.

Inſtead of a particular *Mood*, or a particular ſet of inflections to expreſs this deſire, the *Engliſh*, *Latins*, &c. expreſs it by an Adverb of wiſhing prefixed to it; the *Latins* by *utinam*; and the *Engliſh* by *would to God*, &c.

The *Subjunctive* is the fourth *Mood*, or manner of conjugating Verbs; thus called, becauſe uſually ſubjoined to ſome other Verbs, or at leaſt to ſome other particle, as *if I love*; *tho' this were true*, &c.

The *Greek* is almoſt the only language, that properly has any *Subjunctive Mood*; though the *French*, *Spaniſh*, and *Italian* have ſome ſhew thereof.—In all other languages the ſame inflections ſerve for the *Optative* and *Subjunctive Moods.*

The *Infinitive* is the fifth *Mood*, or manner of conjugating of Verbs.

The *Infinitive* does not denote any preciſe time, nor does it determine the number, or perſons, but expreſſes things in a looſe indefinite manner, as *to teach*, &c.

In moſt languages both antient and modern, the *Infinitive* is diſtinguiſhed by a termination peculiar to it, as τυπτειν in the *Greek*, *ſcribere* in the *Latin*, *ecrire* in the *French*, *ſcrivere* in the *Italian*, &c. but the *Engliſh* is defective in this point; ſo that to denote the *Infinitive*, they are obliged to have recourſe to the article *to*, except ſometimes when two or more *Infinitives* follow each other.

Of all the *Moods* we have mentioned, the oriental languages have none but the *Imperative.* The method taken for it in *Engliſh* is either to omit the Pronoun, or tranſpoſe it; thus, *we love*, is a ſimple affirmation; *love we*, or *let us*, an *Imperative.*

Tense, *time* (the next thing I conſider in the conjugation of Verbs) is one inflection of Verbs, whereby they are made to ſignify, or diſtinguiſh the circumſtance of time, of the thing they affirm or attribute.

The affirmatives made by Verbs, are different as to point of time; ſince we may affirm a thing *is*, *was*,

was, or *will be*; hence a neceſſity of a ſet of inflections, to denote thoſe ſeveral times; which inflections the *Engliſh* Grammarians call by a barbarous word *tenſes*, from the Latin *tempus*, time; and moſt other languages call them ſimply *times*.

There are but three ſimple *Tenſes*; the *preſent*, as *I love*, *amo*, in *Latin*, *j'aime*, in *French*; the *preter*, *preterit*, or *paſt*, *I have loved*, *amavi*, in *Latin*, *j'ai aimé*, in *French*; and the *future*, as *I will love*, *amabo*, in *Latin*, *j'aimerai*, in *French*.

The ſeveral *tenſes* or *times*, are properly denoted in the *Greek* and *Latin* by particular inflections: in the *Engliſh*, *French*, and other modern tongues, the auxiliary Verbs *to be*, and *to have*, *etre* and *avoir* are called in.

As to the oriental languages, they have only two *ſimple tenſes*, the *paſt*, and *future*, without any diſtinctions of *imperfect*, more than *perfect*, &c. which renders thoſe languages ſubject to abundance of ambiguities, which others are free from.

Verbs when conjugated, are applicable to three different *perſons*, *e. gr.* — *I love*, *J'aime*, is a Verb uſed in the *firſt perſon*; *thou loveſt*, *tu aime*, deſigns the *ſecond perſon*; *he loveth*, *il aime*, marks the *third*, and thus in the plural number: for Verbs in their conjugations, like Nouns in their declenſions admit of two numbers, *viz.* the *ſingular*, and the *plural number*.

From the *Verbs* we'll paſs to the PARTICIPLE, which is an Adjective formed of a Verb; ſo called, becauſe it ſtill *participates* of ſome of the properties of the Verb, retaining the regimen and ſignification thereof; whence moſt authors confound it with Verbs.

There are two kinds of *Participles*, the one called *active*, becauſe expreſſing the ſubject, which makes the action of the Verb; as *legens*, *audiens*, *reading*, *hearing*. The other called *paſſive*, becauſe expreſſing the ſubject that receives the action of the Verb, as *lectum*, *auditum*, *read*, *heard*.

As the *Engliſh* Adjectives are not declined, the *participles* being real Adjectives, are not declined neither; in the *Latin*, &c. where the Adjectives are declined, the *participles active*, are declin'd likewiſe. Thus they ſay *audiens*, *audientis*, *audienti*, &c. and in the *French*, the *participles paſſive* are declinable as their Adjectives, as *j'ai leu*, *il a leu*, *nous avous lus*, &c.

In the *Engliſh*, the *Participles* and *Gerunds* are not at all diſtinguiſhable.

GERUND is a ſort of tenſe or time of the infinitive Mood, like to the participle, but indeclinable

It differs from the participle, in that it expreſſes the time, which the participle does not. And from the tenſe, properly ſo called, in that it expreſſes the manner, which the tenſe does not.

Grammarians are much embaraſſed to ſettle the nature and character of *Gerunds*: it is certain they are no verbs, nor diſtinct moods of verbs, in regard they do not mark any judgment or affirmation of the mind, which is the eſſence of the verb. And beſides they have caſes, which verbs have not. ſome, therefore, will have them to be adjectives paſſive, whoſe ſubſtantive is the infinitive of the verb, on this footing, they denominate them *verbal nouns*, or names formed of verbs, and retaining the ordinary regimen thereof; thus ſay they, *tempus eſt legendi libros*, or *librorum*, is as much as to ſay, *tempus eſt τυ legere libros*, *vel librorum*; but others ſtand up againſt this deciſion.

The ADVERB is a particle join'd to a verb, adjective, or participle, to expreſs their manner of acting or ſuffering; or to mark ſome circumſtance or quality ſignified by them.

The word is formed from the prepoſition *ad*, to, and *verbum*, a word, and ſignifies literally a word joined to a verb, to ſhew how, or when, or where one is, does, or ſuffers; as the boy paints *nearly*, writes *ill*; the houſe ſtands *there*, &c.

Not that the *adverb* is confin'd purely to the verb, but becauſe that it is moſt ordinarily in uſe, whence it becomes ſo denominated, κατ' ἐξοχην. We frequently find it join'd to adjectives, and ſometimes even to ſubſtantives, particularly where thoſe ſubſtantives ſignify an attribute, or quality of the thing ſpoken of; *v. gr.* he is *very* ſick, he acts *prudently*, he is truly king.

An *Adverb* is likewiſe join'd ſometimes to another *Adverb*, to modify its meaning, *v. g. very devoutly*; in *French*, *fort devotement*, whence ſome Grammarians chuſe rather to call adverbs, *modificatives*; comprizing under this one general term, both *adverbs*, *conjunctions*, *prepoſitions*, and even *adjectives*.

Adverbs are very numerous, but may be reduced under the general claſſes of *Adverbs* of *time*, of *place*, of *order*, of *quantity*, of *quality*, of *manners*, of *affirmation*, of *doubting*, and of *compariſon*.

A CONJUNCTION is a particle, which expreſſes a relation, or dependance between words and phraſes, thus called, becauſe ſerving to join or connect the parts, or members of a diſcourſe.

Conjunctions render the diſcourſe more ſmooth, and fluent; and ſerve very good purpoſes in the argumentative and narrative ſtyle, but muſt ever be omitted

omitted where a perſon ſpeaks with emotion, as ſerving to weaken and enervate it.

Conjunctions are of various kinds. — *Copulative*, or *conjunctive Conjunctions* are thoſe, which expreſs a relation of union, or compariſon between things; as, and, &; only, *tantum*; as much as, *tantum quantum*; in the ſame manner as, *quemadmodum*; neither more nor leſs, *tantumdem*; inaſmuch as, *quippe*; not only, *non modo*; but alſo, *ſed etiam*, &c.

CONJUNCTIONS *adverſative* are thoſe, which expreſs a reſtriction, or contrariety; as, but, *ſed*; nevertheleſs, *tamen*; although, *etiamſi*; far from, *adeo non*.

CONJUNCTIONS *cauſal* are thoſe, that ſhew that the reaſon of ſomething is brought; as, for, *nam*; becauſe, ſeeing, *quippe quia*; the rather ſince, *eo magis quo*; inaſmuch as, *quatenus*.

CONJUNCTIONS *concluſive* are thoſe, which denote a conſequence drawn; as, for which reaſon, *qua propter*; but then, *atqui*; of conſequence, *ideoque*: ſo that, *ita ut*, &c.

CONJUNCTIONS *conditional* are thoſe, which import a condition; as, if, *ſi*; if not, *ſi minus*; on condition that, *eâ lege ut*; provided that, *dummodo ut*; in caſe of, *ſi vero*.

CONJUNCTIONS *continuative* are thoſe, which expreſs a ſucceſſion, or continuation of the diſcourſe; as in effect, *reipſa*; even, *etiam*; whatever it be, *quicquid ſit*.

CONJUNCTIONS *diſjunctive* are thoſe, which expreſs a relation of ſeparation or diviſion; as, neither, *nec*; whether, *ſive* or *vel*.

CONJUNCTIONS, *dubitative* are thoſe, which expreſs ſome doubt or ſuſpenſion of opinion, as if, *that is to ſay*; if, &c.

CONJUNCTIONS *exceptive* are, if it be not, *niſi ſi*; unleſs that, *niſi*, &c.

A PREPOSITION is an indeclinable particle, which yet ſerves to govern the nouns (either of the accuſative, or ablative caſe) that follow it: ſuch are *per*, *prâ*, *propter*, *in*, with, through, from, by, &c.

They are called *prepoſitions*, becauſe *prepoſitions* are placed before the nouns they govern.

INTERJECTION, is an expreſſion uſed to denote ſome ſudden motion, or paſſion of the mind; as *oh! he!*, &c.

As the greateſt part of the expreſſions uſed on thoſe occaſions are taken from nature alone, the real *interjections* in moſt languages are monoſyllables. And as all nations agree in thoſe natural paſſions, ſo do they agree in the ſigns and indications of them, as of *love*, *mirth*, &c.

The *Greeks* confound their *interjections* with adverbs: and the *Hebrews* confound them with their adverbs and prepoſitions, calling them all by the general name *particle*.

Let us now proceed to the laſt diviſion of *Grammar*, *i. e.* the *doctrine* of *ſentences*, which conſiders the placing or joining words together, called *ſyntax*.

The SYNTAX is the conſtruction, or connection of the words of a language into ſentences, or phraſes: or the manner of conſtructing one word with another, with regard to the different terminations thereof, preſcribed by the rules of Grammar. For the office of *Syntax* is to conſider the natural ſuitableneſs of words with reſpect to one another; in order to make them agree in the gender, number, perſon, mood, &c.

It is properly the *Syntax* that gives the forms to language, and it is that on which turn the moſt eſſential parts of *Grammar*.

There are two kinds of *Syntax*, the one of *concord*, wherein the words are to agree in gender, number, caſe and perſon. The other of *regimen* or *government*, wherein one word governs another, and occaſions ſome variation therein.

The firſt, generally ſpeaking, is the ſame in all languages, as being the natural ſeries of what is uſed almoſt every where; the latter to diſtinguiſh diſcourſe. Thus the diſtinction of two numbers, ſingular and plural, has rendered it neceſſary to make the adjective agree with the ſubſtantive in number; that is, to make the one ſingular or plural, when the other is ſo; for as the ſubſtantive is the ſubject confuſedly, though directly marked by the adjective; if the ſubſtantive expreſſes ſeveral, there muſt be ſeveral ſubjects expreſſed in that form by the adjective; and by conſequence it ought to be in the plural, as *homines docti*, learned men: but there being no variety of termination in the adjective, in *Engliſh*, to diſtinguiſh the number, it is only implied.

The diſtinction of maſculine and feminine gender obliges the languages, which have diſtinct terminations to have a *concordance*, or *agreement* between the ſubſtantive and adjective, in *gender*, as well as number: and for the ſame reaſon, the verbs are to agree with the nouns and pronouns in *number* and *perſon*. If at any time we meet with any thing that ſeems to contradict theſe rules, it is by a figure of ſpeech, *i. e.* by having ſome word underſtood, or by conſidering the thoughts rather than the words themſelves.

The *Syntax of government*, on the contrary, is generally arbitrary, and on that account differs in moſt languages. One language, for inſtance, forms their regimen by *caſes*, as the *Latin* and *Greek*: others uſe *particles*, in lieu thereof, as the *French*, *Engliſh*, *Italian*, *Spaniſh*, &c.

One or two general rules, however, may be here noted, which obtain in all languages. 1. That there is no *nominative caſe*, but has a relation to

ſome

ſome *verb*, either expreſſed or underſtood: ſince we do not only ſpeak to expreſs what we perceive, but to expreſs what we think of what we perceive, which is done by the verb.

2. That there is no *verb*, but has its *nominative caſe*, either expreſſed or underſtood; for the office of the verb being to affirm, there muſt be ſomething to affirm of, which is the ſubject, or nominative caſe of the verb, except before an infinitive, where it is an accuſative, as, *ſcio Petrum eſſe doctum*, I know *Peter* to be learned.

3. There is no *adjective* but has a relation to ſome *ſubſtantive*, becauſe the adjective marks confuſedly the ſubſtantive; which is the ſubject of the form or quality, marked by the adjective.

4. That there never comes any *genitive caſe*, but what is govern'd by ſome other noun.

5. The *government of verbs* is frequently taken from various ſorts of references, included in the caſes, according to the practice of cuſtom or age; which yet does not change the ſpecifick relation of each caſe, but only ſhews that cuſtom has made choice of this or that. Thus the *Latins* ſay, *juvare aliquem, & opitulari alicui:* the *French*, *ſervir quelqu'un, & ſervir a quelque choſe*; and in the *Spaniſh*, the generality of verbs govern indifferently a dative and an accuſative caſe.

It is eaſy to underſtand, that theſe *general rules* are the foundation of the doctrine of *ſentences*; ſince a *ſentence* denotes a *period*, or a ſet of words comprehending ſome perfect ſenſe, or ſentiment of the mind.

Every *ſentence* comprehends at leaſt three words.

In every *ſentence* there are two parts neceſſarily requir'd; a *noun* for the *ſubject*, and a *definite verb*: whatever is found more than theſe two, affects one of them, either immediately or by the intervention of ſome other, whereby the firſt is affected.

Again, every *ſentence* is either *ſimple* or *conjunct*: a *ſimple ſentence* is that conſiſting of one ſingle ſubject, and one finite verb. — A *conjunct ſentence* contains ſeveral ſubjects, and finite verbs, either expreſly or implicity.

A *ſimple ſentence* needs no point or diſtinction, only a period to cloſe it; as, *a good man loves virtue for itſelf*. In ſuch a *ſentence*, the ſeveral adjuncts affect either the ſubject or the verb in a different manner; thus the word *good*, expreſſes the quality of the ſubject; *virtue*, the object of the action; and, *for itſelf*, the end thereof. Now none of theſe adjuncts can be ſeparated from the reſt of the *ſentence*, for if one be, why ſhould not all the reſt? and if all be, the *ſentence* will be minced into almoſt as many parts as there are words.

But if ſeveral adjuncts be attributed in the ſame manner, either to the ſubject or to the verb, the *ſentence* becomes *conjunct*, and is to be divided into parts.

In every *conjunct ſentence*, as many ſubjects, or as many finite verbs as there are, either expreſly, or implied, ſo many diſtinctions may there be; thus, *my hopes, fears, joys, pains, all center in you*; and thus *Cicero*; *Catilina abiit, exceſſit, evaſit, erupit*. The reaſon of which pointing is obvious; for as many ſubjects or finite verbs as there are in a *ſentence*, ſo many members does it really contain. Whenever, therefore, there occur more nouns than verbs, or contrarywiſe, they are to be conceived as equal; ſince, as every ſubject requires its verb, ſo every verb requires its ſubject, wherewith it may agree, excepting perhaps in ſome figurative expreſſions.

Indeed there are ſome other kinds of *ſentences*, which may be ranked among the *conjunct* kind, particularly the *abſolute ablative*, as it is called; thus, *phyſicians, the diſeaſe once diſcover'd, think the cure half wrought*. Where the words, *diſeaſe once diſcover'd*, are equivalent to, *when the cauſe of the diſeaſe is diſcovered*. So alſo in nouns, added by appoſition; as, *the* Scots, *a hardy people, endured it all*; ſo alſo in vocative caſes, and interjections; as, *this, my friend, you muſt allow me*; and, *what, for heaven ſake, would he be at?*

The caſe is much the ſame when ſeveral adjuncts affect either the ſubject of the *ſentence*, in the verb, in the ſame manner, or at leaſt ſomething whereby one of them is affected; as, *a good, wiſe, learned man, is an ornament to the common wealth*; where the ſeveral adjectives denoting ſo many qualities of the ſubject, are to be ſeparated from one another. Again, when I ſay, *your voice, countenance, geſture terrified him*. The ſeveral nominative caſes denote ſo many modes of the verb, which are likewiſe to be diſtinguiſhed from each other. The caſe is the ſame in adverbs; as, *he behaved himſelf modeſtly, prudently, virtuouſly*. In the firſt example, the adjuncts immediately affect the ſubject; in the third, the verb; in the following one, another adjunct; as, *I ſaw a man loaden with age, ſickneſs, wounds*.

Now as many ſuch adjuncts as there are, ſo many ſeveral members does the *ſentence* contain, which are to be diſtinguiſhed from each other, as much as ſeveral ſubjects, or finite verbs; and that this is the caſe in all *conjunct ſentences*, appears hence, that all thoſe adjuncts, whether they be verbs or nouns, *&c.* will admit of a *conjunction copulative*, whereby they may be joined together: but wherever there is a copulative, or room for it, there a new member of a *ſentence* begins.

The *points* uſed to divide a diſcourſe into periods, and members of periods (to expreſs the pauſes to be made in the reading thereof) are four, *viz.* the *period* or *point*, *colon*, *ſemicolon*, and *comma*.

The *period*, *point*, or full ſtop, is thus formed (.) and ſhews that the ſenſe of the ſentence is complete.

A *colon* is a point or character, formed thus (:) ſerving to mark a pauſe, and to divide the members of a period. Grammarians generally aſſign the uſe of a *colon*, to mark the middle of a period, or to conclude a ſenſe leſs perfect than the dot or period. Others ſay a *colon* is to be uſed when the ſenſe is perfect, but the ſentence not concluded.

The mark or character of the *ſemicolon* is (;) It has its name, as having a ſomewhat leſs effect than a *colon*, or as demanding half its pauſe. The *ſemicolon* is properly uſed to diſtinguiſh the conjunct members of ſentences. By a conjunct member of a ſentence, we mean ſuch a one as contains at leaſt two ſimple members. Whenever then a ſentence can be divided into ſeveral members of the ſame degree, which are again diviſible into other ſimple members, the former are to be ſeparated by a *ſemicolon*.

A *comma* is a point or character form'd thus (,) ſerving to mark a ſhort ſtop or pauſe; and to divide the members of a period.

The *comma* ſerves to diſtinguiſh thoſe members of a period, in each whereof is a verb, and the nominative caſe of the verb. Beſides this, the *comma* is uſed to diſtinguiſh in the ſame member of a period, ſeveral nouns ſubſtantive, or nouns adjective, or verbs not united by a conjunction; for if they be united by a conjunction, the *comma* is omitted: it may alſo be omitted between two phraſes that are very ſhort, eſpecially if they depend on the ſame regimen, and are united by a conjunction.

The pauſes to be made at each of theſe points or ſtops, are equal to the time we can ſay *one* for a *comma*: *one, one*, for a *ſemicolon*: *one, one, one*, for a *colon*: and *one, one, one, one*, for a *period*.

Beſides theſe above-mention'd, the *Grammar* admits of other *punctuations*, viz. *the parentheſis* mark'd thus ( ) and which includes ſome words, which, if left out, would not break, or alter the ſenſe, or ſmoothneſs of the ſtyle. The *interrogation* mark'd thus ? and which is made at aſking a queſtion. *Note of admiration* or *exclamation* thus ! *Hyphen* thus - which couples together two words, as *well-ſpring*, and is uſed when a word is parted into ſyllables, at the end of a line. The ſection thus § which divides a large diſcourſe into ſeveral parts. *Aſteriſm* thus * which refers to the margin. *Obeliſk* thus † notes from the matter to the margin. *Note of citation* thus " when authors are cited word for word. *Apoſtrophe* thus ' when a letter is purpoſely left out, as 'tis, for *it is*; 'twas, for *it was*. *Indaction* thus ∧ is made to bring in ſomething omitted. *Diæreſis* or *Dialyſis* thus ¨ is uſed to part a diphthong, and is made over the vowels *aïr*, *poëta*, that it may not be pronounced *air*, *peta*. *Grave accent* thus ` uſed over a vowel, when the voice is depreſſed. *Acute accent* thus ´ when the voice is to be raiſed higher. *Creſis* thus ˆ uſed over *circumflex* ſyllables, long by nature, as *dî* for *dij*, *amârunt* for *amaverunt*.

Grammar admits of figures, which occaſion changes in the form, &c. of words, there are *ſyncope*, *apocope*, *apoſtrophe*, *aphæreſis*, *proſtheſis*, *epenthesis*, *paragoge*, *metathesis*, &c.

SYNCOPE denotes an eliſion or retrenchment of one or more letters, or ſyllables from a word: as when we ſay *virum*, for *virorum*, and *manet alta repôſtum*, for *repoſitum*.

APOCOPE is a figure wherein part of the end of a word is cut off; as in *dic* for *dice*, *fac* for *face*, *nil* for *nihil*, *hyp* or *hypo*, for *hypochondriacal*.

APOSTROPHE denotes a note or character, placed over a letter, in lieu of a vowel, to denote that the vowel is cut off, and not to be pronounced: as *ev'n* for *even*; *th' angelick hoſt*, for *the angelick*, &c.

APHÆRESIS is a figure, whereby ſomething is taken away from the beginning of a word; thus *Ciconia*, by *aphæreſis*, is wrote *Conia*; *contemnere*, *temnere*; *omittere*, *mittere*, &c.

PROSTHESIS is a ſpecies of metaplaſm; being the prefixing of ſome letter, or ſyllable at the beginning of a word; as, in *gnavus*, for *navus*.

EPENTHESIS is the addition, or inſertion of a letter or ſyllable, in the middle of a word. — As *relligio* for *religio*; *mavors* for *mars*.

PARAGOGE is a figure, whereby a word is lengthened out, by adding a ſyllable at the end thereof: as in *dicier* for *dici*.

METATHESIS is a figure, whereby letters or ſyllables of a word are tranſpoſed, or ſhifted out of the natural ſituation: as *evandre* for *evander*, *ipræ* for *præi*.

I ſhall add to this treatiſe on *grammar*, ſome remarks upon *languages*.

A LANGUAGE is a ſet of words, which any people have agreed upon, whereby to communicate their thoughts to each other.

There is found a conſtant reſemblance between the genius, or natural complexion of each people, and the language they ſpeak.—Thus the *Greeks*, a polite, but voluptuous nation, had a *language* perfectly ſuitable, full of delicacy and ſweetneſs.—The *Romans*, who ſeem'd only born to command, had a *language* noble, nervous, and auguſt; and their deſcendants, the *Italians*, are deſcended into ſoftneſs and effeminacy; which ſome ſay, is as viſible in their *language*, as in their manners.—The *language* of the *Spaniards*, is full of that gravity, and haughtineſs of air, which makes the diſtinguiſhing

character

character of that people.—The *French*, who have a world of vivacity, have a *language* that runs extremely briſk and lively.—And the *Engliſh*, who are naturally blunt, thoughtful, and of few words, have a *language* exceeding ſhort, conciſe, and ſententious.

The diverſity of *languages* is generally allowed to have taken its riſe from the confuſion of *Babel*, both by *Jews*, *Chriſtians*, and *Mahometans*.

Languages are divided into *original*, or *mother tongues*; as the *Hebrew* and *Arabick* in the eaſt, the *Teutonick* and *Sclavonick* in the weſt.

Secundary or *derivative languages*, which are thoſe formed of a mixture of ſeveral others, as *Latin*, *Engliſh*, *French*, &c.

Kircher will have the *Coptick* a mother tongue independant of all others. *Du John* maintains the *Gothick*, a primitive *language*, and the mother of all the *Teutonick* tongues; that is, of all thoſe ſpoke in the north. Some add the *Baſque* or *Biſcayan*, and *Bas Briton*, to the number of mother tongues, imagining them to have been thoſe of the antient *Celtæ* or *Gauls*.

Languages are alſo divided into *learned*, or *dead languages*, and *living languages*.

Learned, or *dead languages*, are thoſe which only ſubſiſt in books, and which muſt be learned by the rules of *Grammar*, as the *Hebrew*, *Arabick*, *Syriack*, *Chaldee*, *Greek*, and *Latin*.

HEBREW is the *language* ſpoke by the *Hebrews*, and wherein all the books of the Old Teſtament are wrote. Whence it is alſo called the *holy* and *ſacred language*.

The *Hebrew* appears to be the moſt antient of all the *languages* in the world, at leaſt it is ſo with regard to us, who know no older.

The *Hebrew*, ſuch as we have it in the holy ſcripture, is a very regular, analogical *language*; and particularly ſo in its conjugations. Properly ſpeaking, there is but one ſimple conjugation, but this is varied in each verb, ſeven or eight ways, which has the effect of ſo many different conjugations, and affords a great number of expreſſions, whereby to repreſent under one ſingle word, all the different modifications of a verb; and ſeveral ideas at once; which in the modern, and moſt of the antient and learned languages, are to be expreſſed only by phraſes

The original and primitive words in this *language*, which they call *radices*, *i. e.* roots, rarely conſiſt of more than three letters, or two ſyllables, which are expreſſed by two ſounds, or by the ſame ſound redoubled, which is indicated by a point.

Uſually they only reckon five vowels in the *Hebrew*, which are the ſame with ours, *viz.* *a*, *e*, *i*, *o*, *u*; but then each vowel is divided into two, *a*, *long*, and *a*, *breve*, or *ſhort*: the ſound of the former is ſomewhat graver and longer; and that of the latter ſhorter, and more acute. It muſt be added that the two laſt vowels have quite different ſounds; different we mean in other reſpects beſides quantity and degrees of elevation.

To theſe ten or twelve vowels muſt be added ſome others, called *ſemi-vowels*, which are only ſlight motions ſerving to connect the conſonants, and make the eaſier tranſitions from one to another.

The number of accents is prodigious in the *Hebrew*; there are near forty different ones; and of theſe there are ſeveral whoſe uſe is not well aſcertained, notwithſtanding all the inquiries of the learned into that matter.

In the general, we know theſe three things, 1. That they ſerve to diſtinguiſh the ſentences, and the members thereof, like the points, and comma's, *&c.* in *Engliſh*. 2. To determine the quantity of the ſyllables: and 3. To mark the tone wherewith they are to be ſpoke or ſung. It is no wonder then, there ſhould be more accents in the *Hebrew* than in other languages; as they do the office of three different things, which in other languages are called by different names.

The language uſed by the *Rabbins* in the writings they have compoſed, is called *rabbinical*, or *modern Hebrew*. The baſis or body hereof is the *Hebrew* and *Chaldee*, with divers alterations in the words of thoſe two languages; the meaning whereof they have conſiderably enlarged and extended. Abundance of things they have borrowed from the *Arabick*. The reſt is compoſed of words and expreſſions chiefly from the *Greek*, ſome from the *Latin*, and others from the other modern tongues; particularly that ſpoken in the place where each *Rabbin* lived, or wrote.

The *rabbinical Hebrew*, muſt be allowed a very copious language. M. *Simon* obſerves, that there is ſcarce any art or ſcience, but the *Rabbins* have treated thereof in it. They have tranſlated moſt of the antient philoſophers, mathematicians, aſtronomers, and phyſicians; and have wrote themſelves on moſt ſubjects: they do not want even orators and poets. Add, that this language, notwithſtanding it is ſo provided with foreign words, has its beauty viſible enough in the works of thoſe who have wrote well.

The ARABICK is a branch or dialect of the *Hebrew*. Father *Angelo de St. Joſeph*, ſpeaks much of the beauty and copiouſneſs of the *Arabick*.

The SYRIACK, and CHALDEE, are alſo dialects of the *Hebrew*.—The *Chaldee* paraphraſe in the *rabbinical* ſtile, is called *Targum*.

The GREEK, abſolutely ſo called, is the language ſpoken by the antient *Grecians*, and ſtill preſerved

in the works of their authors, as *Plato*, *Ariſtotle*, *Iſocrates*, *Demoſthenes*, *Thucydides*, *Xenophon*, *Homer*, *Heſiod*, *Sophocles*, *Euripides*, &c.

The *Greek* has been preſerved entire longer than any other language known, maugre all the revolutions that have happened in the country where it was ſpoke.

The *Greek* has a great *copia*, or ſtock of words: its inflections are as remarkable for their variety as thoſe of moſt of the other *European* tongues, for their ſimplicity.

The *Greek* was the language of a polite people, who had a taſte for arts and ſciences, which they cultivated with ſucceſs. In the living tongues are ſtill preſerved a great number of *Greek* terms of art; ſome deſcended to us from the *Grecians*, and others formed a new. When a new invention, machine, rite, order, inſtrument, *&c.* has been diſcovered, recourſe has commonly been had to the *Greek* for a name; the facility wherewith words are there compounded, readily affording us names expreſſive of the uſe, effect, *&c.* of ſuch inſtruments.

Modern, or *vulgar Greek*, is the language now ſpoke in *Greece*. One may diſtinguiſh three ages of the *Greek* tongue; the firſt ended at the time when *Conſtantinople* became the capital of the *Roman* empire; not but there were ſeveral books, particularly of the fathers of the church, wrote with great purity after that time; but as religion, law, and policy, both civil and military, began then to introduce new words into the language, it ſeems neceſſary to begin the ſecond age of the *Greek* tongue from that epocha; which laſted to the taking of *Conſtantinople* by the *Turks*, where the laſt age commences.

The Latin was firſt ſpoken in *Latium*, and afterwards at *Rome*.

Some authors rank the *Latin* among the number of original languages, but by miſtake; it is formed principally from the *Greek*, and particularly the *Æolick* dialect of that tongue; tho' it has a great number of words which it borrowed from the languages of the *Etruſci*, *Oſci*, and other antient people of *Italy*: and foreign commerce and wars, in courſe of time added a great many more.

The *Latin* is more figurative than the *Engliſh*, leſs pliant than the *French*, leſs copious than the *Greek*, leſs pompous than the *Spaniſh*, leſs delicate than the *Italian*, but cloſer and more nervous than any of them.

After the tranſlation of the ſeat of the empire from *Rome* to *Conſtantinople*, the emperors of the eaſt being always deſirous of retaining the title of *Roman* emperors, appointed the *Latin* to be ſtill retain'd in uſe, both in their reſcripts and edicts. But at length the emperors neglecting the empire of the weſt, abandon'd all care of the *Latin* tongue, and allowed their judges to paſs ſentence in *Greek*.

Charlemagne coming to the empire of the weſt, appointed the law proceedings in ſovereign courts to be in *Latin*, and the notaries were to draw their acts and inſtruments in the ſame tongue: this practice continued a long time through a great part of *Europe*, but at length it gave way, and the *French* took place of the *Latin*, not only in *France*, but in ſome meaſure in *England* too; and the reaſon given for it was, that abundance of difficulties aroſe about underſtanding of *Latin* terms.

The *Latin* however, was prodigiouſly degenerated and corrupted ere it came to be laid aſide. The incurſions of the *Goths* and *Vandals* into *Italy*, brought an inundation of foreign words and phraſes into it, inſomuch that *Valla* calls *Boethius* the laſt *Latin* author. But that was not all; when it once got into the courts of juſtice, it was ſtill worſe handled, till at laſt being introduced among the Monks, and become the common language of *Miſſals* and *Breviaries*, it was debauched to that degree, that it was almoſt become ſcandalous to uſe it.

Living Languages, are thoſe ſtill ſpoke in ſome country or other, and which may be learned by converſation. The moſt popular among theſe are the *French*, *Italian*, *Spaniſh*, *Engliſh*, *German*, &c.

The *French*, as it now ſtands, is no original, or mother language; but a medley of ſeveral: ſcarce any *language*, but it has borrowed words, or perhaps phraſes from.

The *languages* that prevail moſt, and that are, as it were, the baſis thereof, are, 1. The *Celtic*; whether that were a particular *language* itſelf, or whether it were only a dialect of the *Gothic*, as ſpoke in the weſt, and north. 2. The *Latin*, which the *Romans* carried with them into *Gaul*, when they made the conqueſt thereof. And, 3. The *Teutonic*, or the dialect of the *Teutonic*, ſpoke by the *Franks*, when they paſſed the *Rhine*, and eſtabliſhed themſelves with the *Gauls*.

Of theſe three *languages*, in the ſpace of about 1300 years, was the *French* formed; ſuch as it is now found: its progreſs was very ſlow; and both the *Italian*, and *Spaniſh*, were regular *languages* long before the *French*.

As to the analogy of *Grammar*, and the ſimplicity wherewith moods of verbs are formed; the *Engliſh* has the advantage, not only over the *French*, but over all the known languages of the world: but then the turns, the expreſſions, and the idioms of the *Engliſh* are ſometimes ſo quaint, and extraordinary, that it loſes a great deal of the advantage, which its *grammatical* ſimplicity gives it over the reſt.

The

The *French* have but few compound words, wherein it differs widely from the *Greek*, *High Dutch*, and *Engliſh*. This the *French* authors own a great diſadvantage in their language; the *Greek* and *Dutch* deriving a great part of their force and energy, from the compoſition of words; and frequently expreſſing that in one ſounding word, which the *French* cannot expreſs but by a periphraſis. And the diminutives in the *French* are as few as the compounds; the greateſt part of thoſe remaining in uſe, having loſt their diminutive ſignification. But what diſtinguiſhes the *French* moſt, is its juſtneſs, purity, accuracy, and flexibility.

French is the moſt univerſal and extenſive language in *Europe*; the policy of ſtates and courts, has render'd it neceſſary for the miniſters of princes and their officers, *&c.* and the taſte of arts and ſciences has had the ſame effect with regard to the learned.

Tho' the court of *Vienna* was a long while an exception from this rule; *French* was there very little uſed: The Emperor *Leopold* could not bear to hear it ſpoke in his court.

The ſeveral nations who ſpeak *Sclavonick*, do not ſo much ſpeak the ſame language, as different dialects of the ſame language. In ſeveral parts of *Europe*, there are as many different languages as there are ſtates; and in *Italy* there are reckoned no fewer than ten or twelve dialects, ſome of which differ as much from the common *Italian*, as from the *French* or *Spaniſh*.

The *Italian* is derived principally from the *Latin*, and of all the languages formed from the *Latin*, there is none which carries with it more viſible marks of its original, than the *Italian*. It is accounted one of the moſt perfect among the modern tongues, containing words, and phraſes to repreſent all ideas, to expreſs all ſentiments, to deliver one's ſelf on all ſubjects, to name all the inſtruments and parts of arts, *&c.*

The *Spaniards* ſeem to place the nobleneſs and gravity of their language, in the number of ſyllables, and the ſwelling of words, and ſpeak leſs to be underſtood than to be admir'd. Their terms are big and ſonorous, their expreſſions haughty and boiſterous, and pomp and oſtentation run through all they ſay: their language cannot paint a thought to the life; it always magnifies it, frequently diſtorts it, and does nothing, if it does not exceed nature.

The *Engliſh*, or *Engliſh* tongue, is of *Gothic* or *Teutonic* extraction: this was the root or ſtock, upon which ſeveral other dialects have been ſince grafted.

The language antiently ſpoke in this iſland, was the *Britiſh*, or *Welch*, which is pretended was common to the *Britons* and *Gauls*; and which ſtill ſubſiſts in more or leſs purity in the principality of *Wales*, the county of *Cornwal*, the iſlands, and the province of *Bretagne* in *France*.

As the *Roman* Empire, extending itſelf towards the weſtern parts of *Europe*, came to take in *Gaul* and *Britain*, the *Roman* tongue became propagated therewith; all the edicts, *&c.* relating to publick affairs, being deſignedly wrote in that language.

The *Latin*, however, it is certain, never got ſo much ground, or prevail'd ſo far in *England*, as in *Lombardy*, *Spain*, and the *Gauls*; partly, on account of its great diſtance from *Rome*, and the ſmall reſort of *Romans* hither; and partly for that the entire reduction of the kingdom was not effected till ſo late as the Emperor *Claudius*, when the empire was on the declining hand, and the new province was forced to be ſoon deſerted by its conquerors, called to defend their territories nearer home. *Britain* thus left naked, became an eaſy prey to the *Angli*, or *Anglo-Saxons*, a ſtroling nation from *Jutland* and *Norway*, who took an eaſy poſſeſſion thereof; much about the time that the *Franks*, another *German* nation, enter'd *Gaul*. The *Gauls* and *Franks*, it ſeems, at length came to terms, and found means to unite it into one nation: thus the antient *Gauliſh*, with its mixture of *Latin*, continued the prevailing tongue, only further intermix'd with the *Francic*, or *Lingua Franca*, of their new inmates: But the *Britons* were more conſtant, and determin'd abſolutely to refuſe any ſuch coalition; they had embraced chriſtianity, and their competitors were heathens; rather than admit of ſuch an union, therefore, they choſe to be ſhut up, with their language, in the mountainous parts of *Cambria* or *Wales*.

The *Engliſh Saxons* thus left abſolute lords, changed every thing; their own language was now fully eſtabliſhed, and the very name of the country was henceforth to be *Anglo-Saxon*.

The new language remained in good meaſure, pure and unmixed till the *Norman* invaſion: the attempts of the *Danes*, and the neighbourhood of the *Britons*, indeed wrought ſome leſſer innovations therein; but, in the main, it preſerved itſelf: for as to the *Danes* their language was not much different therefrom. *William* I. and his *Normans*, having got poſſeſſion of *England*, an alteration was ſoon attempted: the conqueſt was not compleat, unleſs the conqueror's language, the *French* or *Franco Gallic*, was introduced; and accordingly all his acts, diploma's, edicts, pleadings, and other judicial matters were written, *&c.* in that tongue.

Under *Henry* II. Dr. *Swift* obſerves, the *French* made a ſtill greater progreſs, by reaſon of the large territories he poſſeſſed on that continent, both from his father and his wife, which occaſioned frequent journies

journies thither, with numerous retinues, *&c.* and for some centuries after, there was a frequent intercourse between *France* and *England*, by the dominions the *English* possessed there, so that the language two or three hundred years ago, seems to have had more *French* than at present.

Besides this alteration from the conquerors, the language in process of time, underwent divers others; and came to have numerous words and phrases of foreign dialects, ingrafted into it, in lieu whereof the antient *Saxon* ones gave way; particularly by means of negotiations, and commerce with other nations; by the marriages of royal families; by the affectation of many writers in most ages, who are fond of coining new words, and altering the usual forms of speech, for the greater delicacy; and by the necessity of framing or borrowing new words, according as new things and inventions turn up. And by such means was the old *Anglo-Saxon* converted into the present *English* tongue.

The perfections ascribed to the *English*, and that in a degree superior to any of the other modern tongues, are,—1. That it is strong and significant; to which the finely-compounded words, formed on the model of the *Greeks*, do not a little contribute.

2. Copious; of which Mr. *Greenwood* gives us instances in the word *striking*: which the *English* have about 30 synonymous expressions for; as to *smite*, *bang*, *beat*, *baste*, *buffet*, *cuff*, *hit*, *thump*, *thwack*, *slap*, *rap*, *tap*, *kick*, *spurn*, *box*, *jerke*, *pummel*, *punch*, &c. and the word *anger*, for which he enumerates above 40.

3. Musical and harmonious; in which respect Mr. *Dennis* makes no scruple to assert it superior even to any other.

The *Teutonic language* is the antient language of *Germany*, which is ranked among the mother-tongues.

The *Teutonic*, now called the *German* or *High Dutch*, is distinguished into *Upper* and *Lower*.

The *Upper* has two notable dialects, *viz.* 1. the *Setlidian*, *Danish*, or perhaps *Gothic*; to which belong the languages spoke in *Denmark*, *Norway*, *Sweden*, and *Iceland*. 2. The *Saxon*, to which belong the several languages of the *English*, *Scots*, *Frisian*, and those on the north of the *Elbe*.

To the *Lower* belong the *Low Dutch*, *Flemish*, &c. spoke through the *Netherlands*, &c.

The *Sclavonic*, is the language of the *Sclavi*, an antient people of *Scythia Europea*; who about the year 518, quitting their native country, ravaged *Greece*, and established the kingdom of *Poland* and *Moravia*, and at last settled in *Illyria*; which thence took the name of *Sclavonia*.

The *Sclavonic* is held, after the *Arabick*, the most extensive language in the world: it is spoke from the *Adriatick* to the *North Sea*, and from the *Caspian* to *Saxony*, by a great variety of people, all the descendants of the antient *Sclavi*, *viz.* the *Poles*, *Muscovites*, *Bulgarians*, *Carinthians*, *Bohemians*, *Hungarians*, *Prussians*, *Suabians*, &c. each of whom however, have their particular dialect; only the *Sclavonic* is the common mother of their several languages, *viz.* the *Polish*, *Russian*, *Hungarian*, &c.

The *Japanese language* is very curious, wherein they have several words to express one thing, some in derision, others in honour; some for the prince, others for the people; as also for the quality, age, and sex of the speaker, and person spoke to.

The *Ethiopian*, or *Abyssinian tongue* seems to have some affinity with the *Hebrew*, and *Chaldee*.

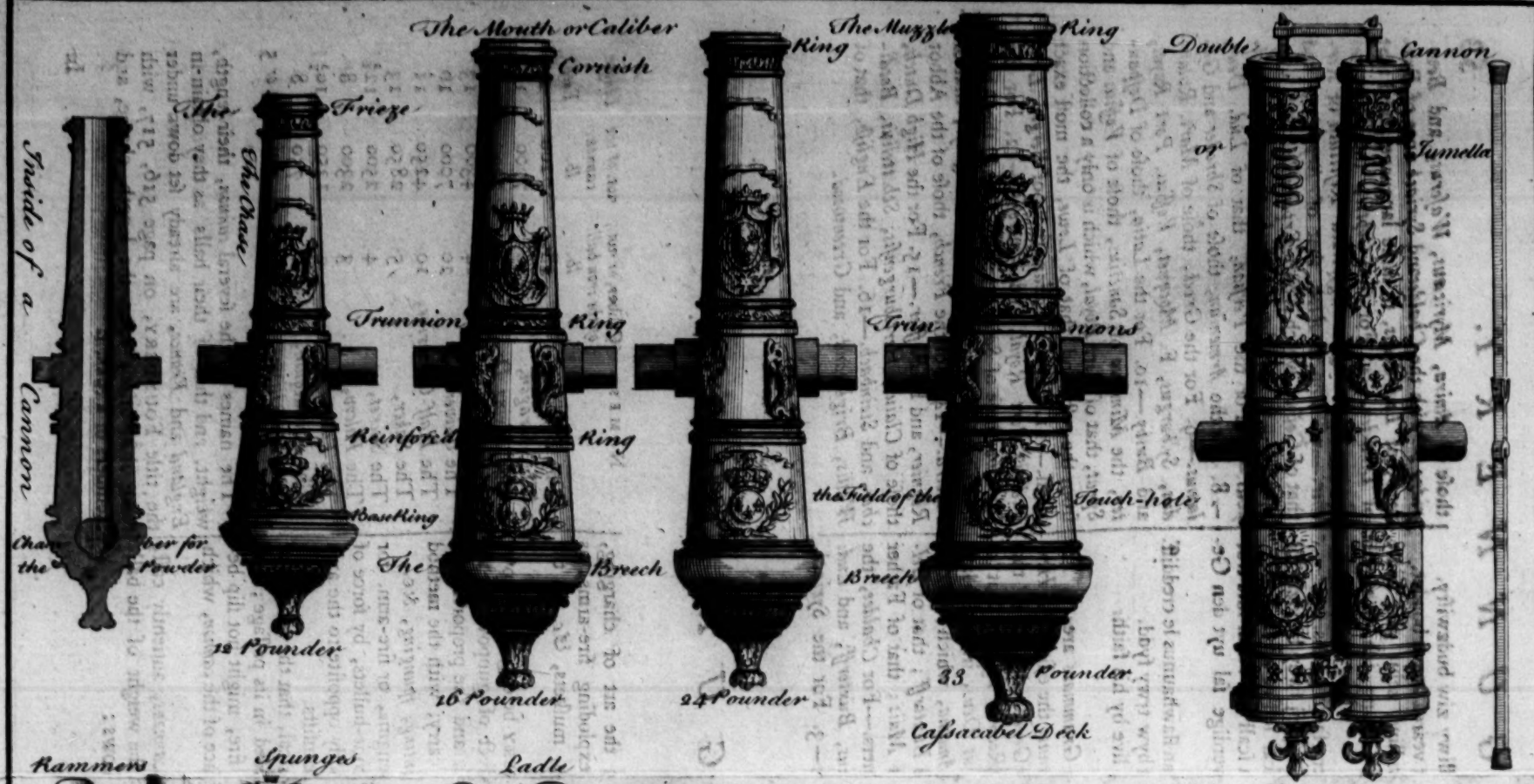
The *languages* of other countries in *Africa*, and *America* are but mere jargons, wholly rude, and harsh to themselves, and unknown, as well as unintelligible to us.

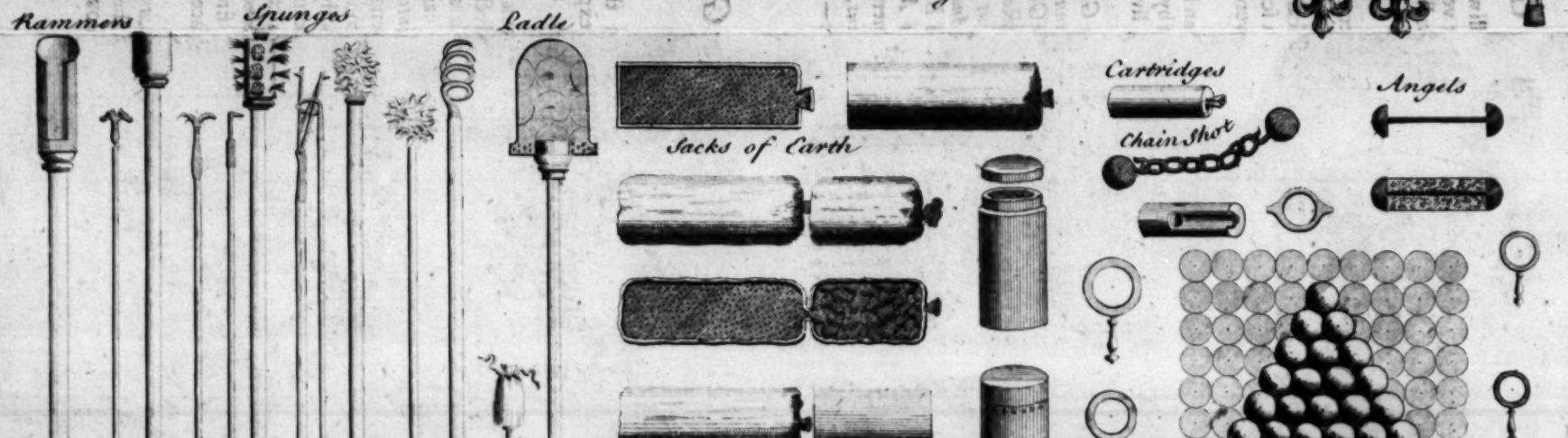
The difference and affinity of several *languages*, may be seen from that famous sentence of *Habbakuk*, ii. 4. *But the just shall live by his faith*, expressed in thirty-three *languages*, or several tongues, which I have set down in our common printing letters.

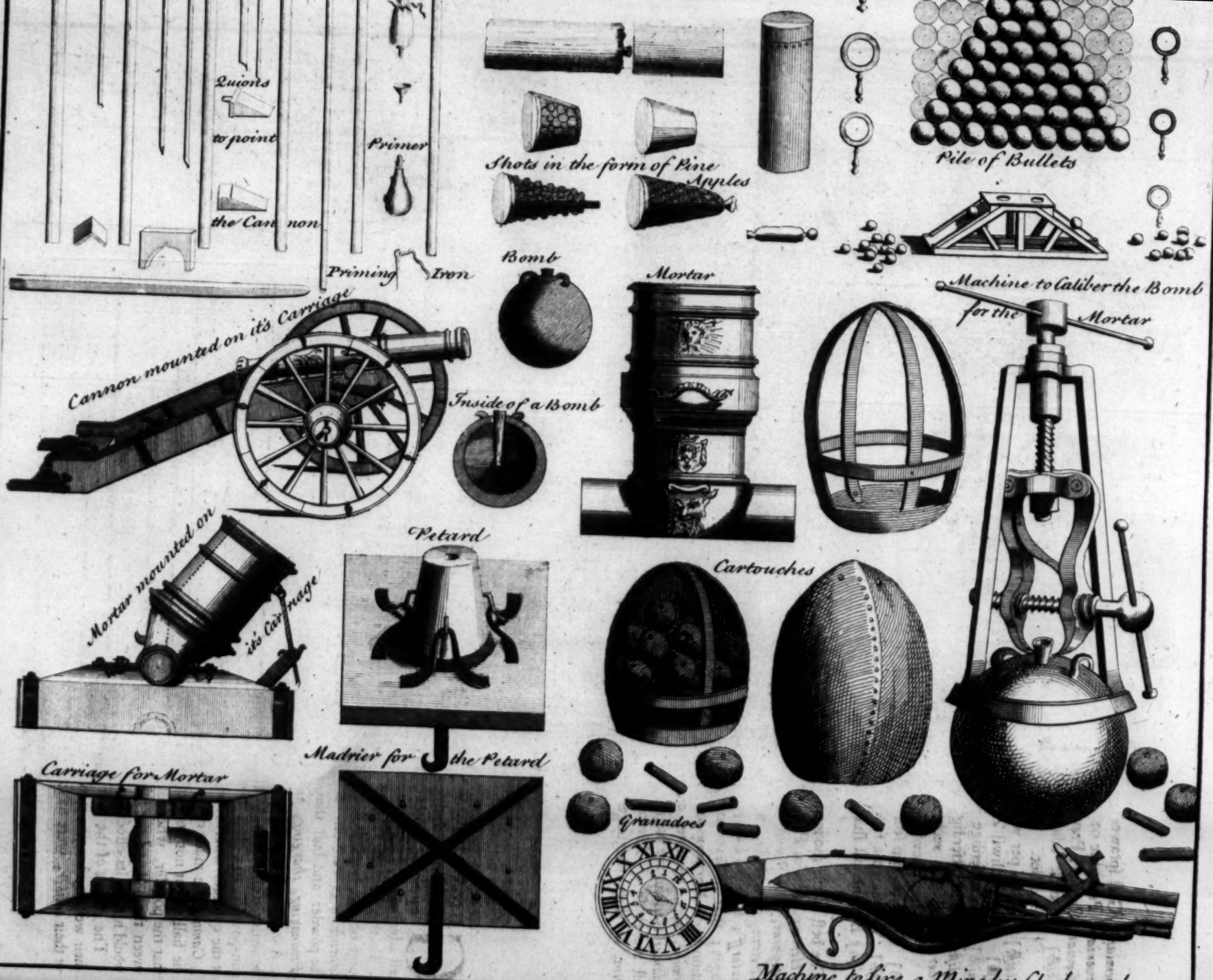
Hebrew] Ve-tzaddig, be emunatho jichjch.
Chaldee] Vetzaddikaia al kusthethon jith kaigemun.
Syriack] Decana min himenuta nacha.
Arabick] Vaadili minalamj anj jaccaij.
Greek] Ho de dikaios ec pisteos mec zesetaij.
Latin] Justus autem ex fide suâ vivet.
Spanish] El justo en su fe bivira.
Italian] Il giusto vivera per la sua fede.
Portugal] Oa justo em sua fei vivara.
French] Mais le just vivera de sa foy.
Armenian] Shedeck mart eer serdoven kapree,
Persian] Rast adem eis fisk hodmigzeratt.
Georgian] Mortalee katseca tavis sumartlitta darchebis.
Javan, *Mallay*] Ozany betool deah-pooniah emaun ollough cubbool.
East Indian, *Surat*] Neek zaut oousskah ema un coodawtah haut.
West-Indian, *New-England*] Sampivenssanuta pish pomantum kiske wunnamptamoouke.
Hungarian] Azigar ember pedig hit altellel.
Transilvanian] Assigas emberpedig itt altel el.
Moldavian] Wom kudireptate kulege alui traysti.
Tartarian, *Cossackian*] Ho dikaios athropos metis biste too zee.
High-German] Dun der Gerechte bebet sines glaubens.

Bohemian]

GUNNERY.


Inside of a Cannon
The Mouth or Caliber
Cornish
Frieze
The Chase
Trunnion
Ring
Reinforce
Ring
Base Ring
The Breech
12 Pounder
16 Pounder
The Muzzle Ring
Trunnions
the Field of the Touch-hole
Breech
33 Pounder
24 Pounder
Cassacabel Deck
Double Cannon
or Jumella


Rammers
Spunges
Ladle
Sacks of Earth
Cartridges
Chain Shot
Angels


Quions
to point
Primer
the Cannon
Priming Iron
Shots in the form of Pine Apples
Pile of Bullets
Bomb
Mortar
Machine to Caliber the Bomb for the Mortar
Cannon mounted on it's Carriage
Inside of a Bomb
Petard
Mortar mounted on it's Carriage
Cartouches
Madrier for the Petard
Carriage for Mortar
Granadoes
Machine to fire a Mine by Clock-work

B. Cole sculp.

Bohemian] Geſt ſprawedliwy ziw budzwiſry.
Sclavonian] Pravedne oot vearea zeove boudet.
Moſcovian, Ruſſian] Prawidliwy zejut prze wiare.
Turkiſh] Sadick adam onung ich tikat eila decillet.
Lattoiſh] Taiſus per wicra ſawo girens.
Poliſh] Spraviedliwij Z. wiarij ſwey bendzie zil
Daniſh] Den retferdige ſcal leff ve aff ſin tro.
Swediſh] Then retferdiga ſcall leff ve aff ſine tro.
Netherlandiſh] De rechtverdige ſal uyt den Geloove leven
Iriſh] Dee-yow een feerian flawhaunus le creddiff.
Welſh] Y cyfiawn a fydd byw trwy fydd.
Engliſh] But the juſt ſhall live by his faith.

The beſt of the modern *Grammars* are, 1. For the *Hebrew*, that of *Pagninus*, the edition of *Henry Stephens*, or *le Preux*, at *Geneva*, in 1592; that of *Petrus Martinius*, at *Rochel*, 1592; that of *Buxtorff*; that of *Ludovicus Deus*, in three languages; that of *Sixtinus Amama*, which is a collection from *Martinius* and *Buxtorff*; that of *Bellarmine*, with the notes of *Muis*; that of Father *Sylanter* is uſeful for beginners.—For *Chaldee*, the beſt are thoſe of *Martinius*, *Buxtorff*, and *Lud. Deus*, in three languages.—3. For the *Syriack*, thoſe of *Amira*, *Myricæus*, *Waſerus*, and *Beveridge*; with the *Chaldee* and *Syriack* ones of *Buxtorff*, of *Lud. Deus*, in three languages, and that of *Lembden*.—4. For the *Coptic*, the *Podromus Coptus*, and *Lingua Ægyptiaca Reſtituta* of *Kircher*.—5. The *Arabick*, that of *Erpenius*, and that of *Golius*, which is only *Erpenius*'s a little augmented.—6. For the *Ethiopick*, that of *J. Ludolphus*.—7. For the *Perſian*, that of *Lud. Deus*,—8. For the *Armenian*, thoſe of *Shroder* and *Galamus*.—9. For the *Greek*, thoſe of *Mart. Rulandus*, *Sylburgus*, F. *Mocquet*, *Voſſius*, *Port Royal*, and *Busby*.—10. For the *Latin*, thoſe of *Deſpauter*, the *Minerva* of *Sanctius*, thoſe of *Voſſius* and *Sprat*, that of *Port Royal*, which is only a collection from the reſt, and that of *Lowe*, the moſt exact of all.—11. For the *Italian*, thoſe of *Berger*, *Lanfredini*, *Port Royal*, and *Veneroni*.—12. For the *Spaniſh*, thoſe of *Salazar*, *Port Royal*, the Abbot *de Veirac*, &c.—13. For the *Portugueſe*, that of *Pereira*.—14. For the *French*, thoſe of the Abbot *Regnier*, and F. *Buffier*.—15. For the *High Dutch*, thoſe of *Claius*, *Hertsburgenſis*, *Schottelius*, *Boedicher*, and *Steinbach*.—16. For the *Engliſh*, that of *Wallis*, *Brightland*, and *Greenwood*.

GUNNERY.

GUNNERY, is the art of charging, directing, and exploding fire-arms, as cannons, mortars, muſkets, &c. to the beſt advantage.

To the ART of GUNNERY belongs the knowledge of the force and effect of gunpowder, the dimenſions of cannon, &c. and the proportion of the powder and ball they carry, with the method of *managing*, *charging*, *pointing*, *ſponging*, &c.

A *cannon* is a military engine, or fire-arm, for throwing iron, lead, or ſtone-bullets, by force of gun-powder, to a place exactly oppoſite to the axis of the cylinder whereof it conſiſts.

Cannons are made cylindrical, that the motion of the ball might not be retarded in its paſſage; and that the powder, when on fire, might not ſlip between the ball and the ſurface of the *cannon*, which would hinder its effect.

The names of the braſs *cannons*, antiently caſt, their weight, length, and the weight of the ball, or their *caliber*, were as follows:

NAMES.	Caliber, or wt. of the iron ball.	wt. of the cannon.	Length.
	lb.	lb.	Feet.
The *Baſilisk*,	48	7200	10
The *Dragon*,	40	7000	16½
The *Flying Dragon*,	32	7200	22
The *Serpentine*,	24	4300	13
The *Culverine*,	20	7000	16
The *Half-Culverine*,	10	4250	11
The *Saker*,	5	2850	13
The *Sacret*,	4	2500	12½
The *Falcon*,	3	2300	8
The *Falconet*,	2	1350	10½
The *Ribadequin*,	1	750	8
The *Emerilion*,	¼	400	4 *or* 5

The names of the ſeveral *cannon*, their length, weight, and that of their balls as they obtain in *England* and *France*, are already ſet down under the title FOUNDERY, on page 516, 517, with ſome obſervations upon the length, charge, and members of a *cannon*.

In

In the laſt century was invented, at *Lyons*, a piece of ordnance, called *Jumelle*, or double *cannon*, the figure whereof is in our plate.—The two *cannons* carry a ball or bullet four pounds weight: they are caſt together, with a ſingle touch-hole for both, and they are charged with two iron bars tied together, of 12 foot extent, and 65 pounds weight. This was improved, as may be ſeen in the *Armory* in the Tower of *London*; where there are *cannon* made in this form, with 3, 4, and 12 bores. But they are not found fit for uſe.

Each ſort of *ordnance* is more or leſs *fortified*; which fortification is reckon'd by the thickneſs of the metal at the touch-hole, at the trunnions, and at the muzzle, in proportion to the diameter of the bore.

There are three degrees uſed in fortifying each ſort of ordnance, both *cannons* and *culverines*. Firſt, ſuch as are ordinarily fortified, which are called *legitimate pieces*. Secondly, ſuch whoſe fortifications are leſſen'd, which are called *baſtard pieces*: Thirdly, double fortified pieces, or extraordinary pieces.

The *cannons* double fortified have full one diameter of their bore in thickneſs of metal, at their touch hole, and $\frac{11}{16}$ at their trunnions, and $\frac{7}{16}$ at their muzzle. The *leſſened cannons*, have at their touch-hole, but $\frac{3}{4}$ or $\frac{12}{16}$ of the diameter of their bore in thickneſs of metal, and $\frac{9}{16}$ at their trunnions, and $\frac{5}{16}$ at their muzzle. The *ordinary fortified cannons*, have $\frac{7}{8}$ at the touch-hole, $\frac{5}{8}$ at the trunnions, and $\frac{3}{8}$ at the muzzle. All the *double fortified culverines*, and all leſſer pieces of that kind, have one diameter and $\frac{1}{2}$ at the touch-tole, $\frac{11}{16}$ at the trunnions, and $\frac{9}{16}$ at the muzzle. And all the *ordinary fortified culverines*, are fortified every way as the double fortified *cannons*; and the *leſſen'd culverines*, as the ordinary *cannons* in all points.

Gun powder is a compoſition of *ſalt-petre*, *ſulphur*, and *charcoal* mix'd together.

The *ſulphur* and *ſalt-petre* being purified, and reduced to powder, are put with the *charcoal-duſt* in a mortar, moiſten'd with water or ſpirit of wine, or the like, and pounded 24 hours together; taking care to wet the maſs from time to time, to prevent its taking fire. Laſtly, ſqueezing it through a ſieve, it is formed into little grains or globules; which being dried the powder is compleat.

There are three kinds of *powder*, viz. *cannon-powder*, *muſket-powder*, and *piſtol-powder*; and each of theſe ſorts, is *ſtronger* and *weaker*: which differences ariſe only from the different proportions.

In the *ſtronger cannon-powder*, to every hundred pounds of *ſalt petre*, twenty-five pounds of *ſulphur*, are generally allowed, with the ſame quantity of *charcoal*; and in the *weaker cannon-powder*, to every hundred pounds of *ſalt-petre*, twenty pounds of *ſulphur*, and twenty-four of *charcoal*.

Semienowitz preſcribes for mortars, an hundred pounds of ſalt-petre, twenty-five of ſulphur, and as many of charcoal; for great guns an hundred pounds of ſalt-petre, fifteen of ſulphur, and eighteen of charcoal.

Miethus extols the proportion of one pound of ſalt-petre to three ounces of charcoal; and two, or two and a quarter of ſulphur. He adds, that the uſual practice of making the *gun-powder* weaker for mortars than *cannons*, as in the example above, is without any foundation, and renders the expence needleſly much greater: for, whereas, to load a large mortar, twenty-four pounds of common powder is requir'd; and conſequently to load it ten times, two hundred and forty pounds; he ſhews, by calculation, that the ſame effect would be had by one hundred and eighty pounds of the ſtrong powder.

There are three ways to prove the goodneſs of *gun-powder*. 1. By *ſight*; for if it be too black, it is too moiſt, or has too much charcoal in it; ſo alſo if rubbed upon white paper, it blackens it more than good powder does: but if it be a kind of azure colour, ſomewhat inclining to red, it is a ſign of good powder. 2. By *touching*; for if in cruſhing it with your fingers ends, the grains break eaſily and turn into duſt, without feeling hard, it has too much coal in it; or if, in preſſing under your fingers upon a ſmooth, hard board, ſome grains feel harder than the reſt, or, as it were, dent your fingers ends, the ſulphur is not well mix'd with the nitre, and the powder is naught. 3. By *burning*; wherein heaps of powder are laid upon white paper, three inches or more aſunder, and one of them fired; which, if it only fires all away, and that ſuddenly, and almoſt imperceptibly, without firing the reſt, and make a ſmall thundering noiſe, and a white ſmoak riſes in the air, almoſt like a circle, the powder is good; if it leaves black marks, it has too much coal, or is not well burnt: if it leaves a greaſineſs, the ſulphur or nitre is not well cleanſed or order'd. Again, if two or three corns are laid on paper an inch diſtant, and fire be put to one of them, and they all fire at once, leaving no ſign behind but a white ſmoaky colour in the place, and the paper not touch'd, the powder is good.

To recover damag'd powder, the method of the powder merchants is, to put part of the powder on a ſail-cloth, to which they add an equal weight of what is really good; and with a ſhovel mingle it well together, dry it in the ſun, and barrel it up, keeping it in a dry and proper place.

Obſervations on the force of Gun-powder. *Gun-powder* fired either in *vacuum*, or in air, produces by

by its explosion a permanent elastic fluid. For if a red-hot iron be included in a receiver, after being exhausted, and gun-powder be let fall on the iron, the powder will take fire, and the mercurial gage will suddenly descend upon the explosion; and though it immediately ascends again, yet it will never rise to the height it first stood at, but will continue depressed by a space proportioned to the quantity of gun-powder which was let fall on the iron.

The same production likewise takes place, when gun-powder is fired in the air: for if a small quantity of powder be placed in the upper part of a glass tube, and the lower part of the tube be immerged in water, and the water be made to rise so near the top, that only a small portion of air is left in that part where the gun-powder is placed; if in this situation the communication of the upper part of the tube with the external air be closed, and the powder be fired, which will easily be done by a burning-glass, the water will in this experiment descend upon the explosion as the quicksilver did in the last; and will always continue depressed below the place at which it stood before the explosion; and the quantity of this depression will be greater, if the quantity of powder be increased, or the diameter of the tube be diminished. From whence it is proved, that as well in air as in a vacuum, the explosion of fired powder produces a permanent elastic fluid. It also appears from experiment, that the elasticity or pressure of the fluid produced by the firing of gun-powder, is, *cæteris paribus*, directly as its density.

This follows from hence, that if in the same receiver a double quantity of powder be let fall, the mercury will subside twice as much as in the firing of a single quantity.

To determine the elasticity and quantity of this elastic fluid, produced from the explosion of a given quantity of gun-powder, Mr. *Robins* premises, that the elasticity of this fluid increases by heat, and diminishes by cold in the same manner as that of the air; and that the density of this fluid, and consequently its weight, is the same with the weight of an equal bulk of air having the same elasticity, and the same temperature.

From these principles, and from his experiments, for a detail of which we must refer the reader to his *new principles* of *gunnery*, in *scholium*, to prop. II. he concludes, that the fluid produced by the firing of gun-powder will be $\frac{3}{10}$ of the weight of the gun-powder, and the ratio of the respective bulks of the powder, and the fluid produced from it, will be in round numbers 1 to 244.

Hence we are certain, that any quantity of powder fired in any confined space, which it adequately fills, exerts, at the instant of its explosion, against the sides of the vessels containing it, and the bodies it impels before it, a force at least 244 times greater than the elasticity of common air; or which is the same thing, than the pressure of the atmosphere; and this without considering the great addition, which this force will receive from the violent degree of heat, with which it is endued at that time, the quantity of which augmentation is the next head of Mr. *Robins*'s enquiry.

He determines that the elasticity of the air is augmented when heated to the extremest heat of red hot iron, in the proportion of 796 to $194\frac{1}{3}$, and supposing that the flame of fired gun-powder is not less hot than red hot iron, and the elasticity of the air, and consequently of the fluid, generated by the explosion, being augmented by the extremity of this heat in the ratio of 796 to $194\frac{1}{3}$, it follows that if 244 be augmented in this ratio, the resulting number which is $999\frac{1}{3}$ will determine how many times the elasticity of the flame of fired powder exceeds the elasticity of common air, supposing it to be confined in the same space, which the powder filled before it was fired.

Hence, then, the absolute quantity of the pressure exerted by gun-powder, at the moment of its explosion may be assigned: for since the fluid then generated has an elasticity of $999\frac{1}{3}$, or in round numbers 1000 times greater than common air; and since common air by its elasticity exerts a pressure on any given surface equal to the weight of the incumbent atmosphere, with which it is in *equilibrio*, the pressure exerted by fired powder, before it has dilated itself, is 1000 times greater than the pressure of the atmosphere; and consequently the quantity of this force on a surface of an inch square, amounts to above six tun weight, which force however diminishes as the fluid dilates itself.

The variations of the density of the atmosphere does not any way alter the action of powder by any experiment that can be made. But the moisture of the air has a very great influence on the force of it: for that quantity which in a dry season would communicate to a bullet a velocity of 1700 feet in one second, will not in damp weather communicate a velocity of more than 12 or 1300 feet in a second, or even less, if the powder be bad and negligently kept.

The velocity of expansion of the flame of *gun-powder*, when fired in a piece of artillery, without either bullet, or any other body before it, is prodigious. By the experiments of Mr. *Robins*, it seems this velocity cannot be much less than 7000 feet in a second. This, however, must be understood of the most active part of the flame. For as was observed before, the elastic fluid in which the

activity of gun-powder consists, is only $\frac{1}{10}$ of the substance of the powder, the remaining $\frac{9}{10}$ will in the explosion be mixed with the elastic part, and will by its weight retard the activity of the explosion; and yet they will be so compleatly united, as to move with uncommon motion; but the unelastic part will be less accelerated than the rest, and some of it will not even be carried out of the barrel, as appears by the considerable quantity of unctuous matter, which adheres to the inside of all fire-arms, after they have been used. These inequalities in the expansive motion of the flame render it impracticable to determine its velocity, otherwise than from experiments.

A *bullet* is an iron ball, wherewith *cannons* are loaded. A *bullet* should be very round, well shaved, and without vacuities.

There are *bullets* of various kinds, *viz. red-hot bullets*, intended to set fire to places, where combustible matters are found. The *bullet* is made red-hot, by digging a place in the earth, and lighting in it a great quantity of charcoal, or sea-coal; and placing over it a strong iron grate. When the fire is well lighted, the *bullets* are placed on the grate, where, in a very short time, they grow red-hot; they are taken out with tongs, or iron ladles for the purpose, and carried into the piece; having before put some clay over the powder the *cannon* is loaded with, lest it should be set on fire by the *red-hot bullet*: then the piece is fired. Wherever the *bullet* passes, and meets with combustible matters, it sets them on fire. But when a trench is before the battery of *red-hot bullets*, hay is rammed over the powder; because, if it was clay, the pieces of it would wound and kill the workmen.

Red-hot bullets are never fir'd but with eight or four pounders. For if they were of a stronger *caliber*, the *bullets* could not be serv'd easily.

Hollow bullets are shells made cylindrical, with an aperture and fusee at one end, which giving fire to the inside, when in the ground, it bursts, and has the same effect with a mine.

Chain bullets consist of two balls joined by a chain, three or four foot a part.

Branch bullets are two balls joined by a bar of iron, five or six inches a part.

Two-headed-bullets, called also *angels*, being two halves of a bullet, joined by a bar or chain: these are chiefly used at sea, for cutting of cords, cables, sails, *&c.* See all those *bullets* in the *plate*.

As *bullets*, as well as the pieces of ordnance, are of different *caliber*, which *caliber*, in a piece of ordnance, is the diameter of the mouth thereof; and in a *bullet*, its circumference; there are means found to proportion these two *calibers* to one another, *viz.* with an instrument called *caliber-rule*, wherein a right line is so divided, as that the first part being equal to the diameter of an iron or leaden ball, of one pound weight, the other parts are to the first, as the diameters of balls of two, three, four, *&c.* pounds, are to the diameter of one ball of one pound.

The *caliber* consists of two thin pieces of brass, six inches long, join'd by a rivet, so as to move quite round each other; the head, or one end of the piece, is cut circular, and one half of its circumference divided into every second degree. On the other half are divisions from one to ten; each again subdivided into four: the use of which divisions and sub-divisions, is when the diameter of a *bullet*, &c. not exceeding ten inches, is taken, the diameter of the semi-circle will, among the divisions, give the length of the diameter, taken between the points of the *calibers*, in inches, and fourth parts.

The degrees on the head, serve to take the quantity of an *angle*, the method of which is obvious. If the *angle* be inward, apply the outward edges to the planes that form the *angle*; the degree cut by the diameter of the semi-circle, shews the quantity of the *angle* sought. For an outward *angle*, open the branches till the points be outward, and applying the streight edges to the planes that form the *angle*, the degrees cut by the diameter of the semi-circle, shew the *angle* requir'd; reckoning from 180, towards the right hand.

On one branch of the *calibers*, on the same side, are, first six inches; and each of these subdivided into ten parts. Secondly, a scale of unequal divisions, beginning at two, and ending at ten, each subdivided into four parts. Thirdly, two other scales of lines, shewing when the diameter of the bore of a piece, is taken with the points of the *calibers* outwards, the name of the piece, whether of the iron or brass, *i. e.* the weight of the bullet it carries, or that it is such or such a pounder, from one to forty-two pounds.

On the other branch of the *calibers*, on the same side, is a line of cords to about three inches radius; and a line of lines on both branches, as on the sector; with a table of the names of the several pieces of ordnance. On the same face is a hand graved, and a right line drawn from the finger towards the center of the rivet, shewing by its cutting certain divisions made on the circle, the weight of an iron shot, when the diameter is taken by the points of the *calibers*. Lastly, on the circle or head, on the same side, are graved several geometrical figures, inscribed in each other, with numbers; as a cube, whose side is supposed one foot; a pyramid on the same base or altitude, and the proportions of their weight, *&c.* a sphere inscribed

ed in a cube; a cylinder, cone, circle, ſquare, &c.

The outſide of the *caliber* ſerves to take the diameter of the mouth of the piece; and the inſide, called the *heel*, that of the *bullet*.

There is another method of taking the *caliber* of the pieces, which is to have a rule very well divided, on which are graved the *calibers*, both of the pieces and bullets. That rule muſt be applied on the mouth of the piece, and the *caliber* is preſently found.

But to be more particular on this important ſubject, here follows the different *calibers* of the pieces of ordnance.

A piece which receives a *bullet* an ounce weight (twelve ſuch ounces to the pound) has of aperture at its mouth, 9 lines and $\frac{1}{16}$ of a line.

That which receives a *bullet* two ounces weight, has of aperture at its mouth, 11 lines and $\frac{1}{4}$ of a line. I'll continue according to the ſame order.

Weight of the bullet. *Ounces.*	*Aperture of the* caliber. *Inches.*	*Lines.*	*Fractions.*
1	0	9	$\frac{1}{16}$
2	0	11	$\frac{1}{4}$
3	1	1	$\frac{7}{16}$
4	1	2	$\frac{1}{2}$
5	1	4	
6	1	4	$\frac{7}{8}$
7	1	5	$\frac{10}{16}$
8	1	6	$\frac{3}{4}$
10	1	8	$\frac{1}{16}$
12	1	9	$\frac{1}{2}$
14	1	10	$\frac{7}{16}$

The piece that receives the *bullet* one pound weight, which makes ſixteen ounces, has of aperture at its mouth, 1 inch, 11 lines, and $\frac{1}{4}$ of a line.

Weight of the bullet. *Ounces.*	*Aperture of the* caliber. *Inches.*	*Lines.*	*Fractions.*
1	1	11	$\frac{1}{4}$
2	2	5	$\frac{10}{16}$
3	3	9	$\frac{1}{16}$
4	3	1	$\frac{7}{16}$
5	3	4	$\frac{1}{2}$
6	3	6	$\frac{3}{4}$
7	3	8	$\frac{15}{16}$
8	3	11	
9	4	0	$\frac{7}{8}$
10	4	2	$\frac{9}{16}$
11	4	4	$\frac{1}{4}$
12	4	5	$\frac{7}{16}$
13	4	7	$\frac{15}{16}$
14	4	8	$\frac{9}{16}$
15	4	9	$\frac{7}{8}$
16	4	11	$\frac{1}{16}$
17	5	0	$\frac{1}{16}$
18	5	1	$\frac{1}{8}$
19	5	2	$\frac{3}{16}$
20	5	3	$\frac{3}{16}$
21	5	4	$\frac{1}{4}$
22	5	5	$\frac{5}{16}$
23	5	6	$\frac{7}{16}$
24	5	7	$\frac{1}{2}$
25	5	8	$\frac{9}{16}$
26	5	9	$\frac{5}{8}$
27	5	10	$\frac{11}{16}$
28	5	11	$\frac{3}{4}$
29	6	0	$\frac{13}{16}$
30	6	1	$\frac{7}{8}$
31	6	1	$\frac{15}{16}$
32	6	2	
33	6	3	$\frac{1}{16}$
34	6	4	$\frac{1}{8}$
35	6	4	$\frac{3}{16}$
36	6	5	$\frac{1}{4}$
37	6	6	$\frac{5}{16}$
38	6	6	$\frac{3}{8}$
39	6	7	$\frac{7}{16}$
40	6	8	$\frac{1}{2}$
41	6	9	$\frac{9}{16}$
42	6	9	$\frac{5}{8}$
43	6	10	$\frac{11}{16}$
44	6	10	$\frac{3}{4}$
45	6	11	$\frac{13}{16}$
46	7	0	$\frac{7}{8}$
47	7	0	$\frac{15}{16}$
48	7	1	
49	7	1	$\frac{1}{16}$
50	7	2	$\frac{1}{8}$
55	7	5	$\frac{7}{16}$
60	7	7	$\frac{15}{16}$
64	7	10	

Sometimes, in lieu of bullets, the pieces are charged with *cartouches*, which are caſes loaded with muſket balls, nails, chains, and pieces of old iron; ſometimes, alſo, with ſmall cannon balls. See the *Fig.* on the plate of *Gunnery*.

There are *cartouches* made in form of grapes, which are muſket balls joined together with pitch, and diſpoſed on a ſmall board, in a pyramidal form round a wooden ſtick, which ariſes from the middle of the board.

The *cartouches* made of tin are the beſt, becauſe they carry further.

There are alſo *cartouches* made in form of pine-apples, whoſe figure is pyramidal. Their baſe is equal to the *caliber* of a bullet, propoſed for the piece they are to be fired with; their height is of a *caliber* and a half; they are dipped in tar, and afterwards rolled on muſket balls, and when well covered with thoſe balls, dipped again in the ſame tar, after which they may be uſed, thruſting the biggeſt foremoſt into the piece. Theſe pine-apples are very good at ſea, becauſe, beſides that the muſket balls flying about wound a great number

of people, the bullet which is at the bottom of the cartouch, does alſo much execution.

There are ſeveral ſorts of *carriages*, for ordnance, *viz.* *Baſtard carriages*, with low wheels; and high wheels. *Sea carriages*, made in imitation of thoſe for ſhip guns: And *carriages for field-pieces*, of which there are two kinds.

The *carriages* muſt be proportion'd to the pieces mounted on them. — The ordinary proportion is, for the *carriage* to have $1\frac{1}{2}$ of the length of the gun; the wheels to be half the length of the piece in eight; four times the diameter or caliber, gives the depth of the planks at the fore end, in the middle $3\frac{1}{2}$.

The piece thus mounted on its carriage, ſeveral inſtruments are employed, ſome to prepare the piece to be loaded, ſome to load it, others to point it, and others to cleanſe it, *&c.* Thoſe inſtruments have each their proper name, which are as follows:

The *lantern* or ladle, (*ibid.*) which ſerves to carry the powder into the piece, and which conſiſts of two parts, *viz.* of a wooden box, appropriated to the caliber of the piece for which it is intended, and of a caliber and a half in length with its vent; and of a piece of copper nailed to the box, at the height of a half caliber.

This *lantern* muſt have three calibers and a half in length, and two calibers in breadth, being rounded at the end to load the ordinary pieces.

The *rammer*, (*ibid.*) which is a round piece of wood, commonly called a *box*, faſtened to a ſtick twelve foot long, for the pieces from twelve to thirty-three pounders; and ten for the eight and four pounders; which ſerve to drive home the powder and ball to the breech.

The *ſponge*, (*ibid.*) which is a long ſtaff or rammer, with a piece of ſheep or lamb ſkin wound about its end, to ſerve for ſcouring the cannon when diſcharged, before it be charged with freſh powder; to prevent any ſpark of fire from remaining in her, which would endanger the life of him who ſhould load her again.

Wad-Skrew, (*ibid.*) which are two points of iron turned ſerpent-wiſe, to extract the wad out of the pieces, when one wants to unload them, or the dirt which had chanced to enter into it.

The *boutefeux*, (*ibid.*) which are ſticks two or three feet long, and an inch thick, ſplit at one end, to hold an end of the match twiſted round it, to fire the cannon.

The *priming iron*, (*ibid.*) which is a pointed iron rod, to clear the touch-hole of the pieces of powder or dirt; and alſo to pierce the cartridge, that it may ſooner take fire.

The *primer*, (*ibid.*) which muſt contain a pound of powder at leaſt, to prime the pieces.

The *quoin of mire*, (*ibid.*) which are pieces of wood with a notch on the ſide to put the fingers on, to draw them back or puſh them forward, when the gunner points his piece. They are placed on the ſole of the carriage.

Leaden plates, which are uſed to cover the touch-hole, when the piece is charged, leſt ſome dirt ſhould enter it and ſtop it.

Before you charge the piece ſponge it well, to clean it of all filth and dirt within ſide; then the proper weight of gunpowder, which powder drive in and ram down; taking care that the powder be not bruiſed in ramming, which weakens its effect; run over it a little quantity of paper, hay, or the like; and then throw in the ball.

To *point*, level, or direct the piece, ſo as to play againſt any certain point, is done by the help of a quadrant with a plummet; which quadrant conſiſts of two branches made of braſs or wood; one about a foot long, eight lines broad, and one line in thickneſs; the other four inches long, and the ſame thickneſs and breadth as the former. Between theſe branches is a quadrant, divided into 90 degrees, beginning from the ſhorter branch, and furniſhed with thread and plummet.

Place the longeſt branch of this inſtrument in the cannon's mouth, and elevate or lower it till the thread cuts the degree neceſſary to hint the propoſed object. Which done, prime the cannon (if not done before) and then ſet fire to it.

To point a cannon well, ſo as to do the execution propoſed, we muſt know the path of a bullet, or the line it deſcribes, from the mouth of the peice to the point where it lodges, which path is commonly called *range*.

If the piece be laid in a line parallel to the horizon, it is called the right or level *range*; and if it be mounted to 45 degrees, the ball is ſaid to have the utmoſt range, and ſo proportionably; all others between 00 degrees and 45, being called intermediate *ranges*.

A ſhot made when the muzzle of a cannon is raiſed above the horizontal line, and is not deſigned to ſhoot directly or point-blank, is called *random ſhot*.

The utmoſt *random* of any piece is about ten times as far as the bullet will go point-blank; and the bullet will go furtheſt when the piece is mounted to about 45 degrees above the level *range*.

Mr. *Norton* obſerves, that

PACES.

	Paces. *Level.*	Paces. *Utmoſt Random.*
A *Baſe* ſhoots ——	60	600
A *Rabinet*, ——	70	700
A *Falconet*, ——	90	900
A *Falcon*, ——	130	1300
Minion ordinary ——	120	1200
Minion largeſt, ——	125	1250
Sacker leaſt, ——	150	1500
Sacker ordinary, ——	160	1600
Sacker old Sort, ——	163	1630
Demi-culverine leaſt,	174	1740
Demi-culverine ordinary	175	1750
Demi-culverine old Sort	178	1780
Culverine leaſt, ——	180	1800
Culverine ordinary,	181	1810
Culverine largeſt,	183	1830
Demi-cannon leaſt,	156	1560
Demi cannon ordinary,	162	1620
Demi-cannon large,	180	1800
Cannon-Royal ——	185	1850

A 24 pounder may very well fire 90 or 100 ſhots, every day in ſummer; at 60 or 75 in winter. In caſe of neceſſity it may fire more. And ſome *French* officers of artillery aſſure, that they have cauſed ſuch a piece to fire every day 150 ſhots in a ſiege.

A 16 and a 12 pounder fire a little more, becauſe they are eaſier ſerv'd. There have even been ſome occaſions, where 200 ſhots have been fired from thoſe pieces, in the ſpace of nine hours, and 138 in the ſpace of five.

To range pieces in a battery, take care to reconnoitre well the ground where it is to be placed, and the road to convey to it, in the night-time, the cannon and the munitions. See page 507, 508.

The pieces muſt be arm'd, each with two lanterns or ladles, a rammer, a ſpunge, and two priming-irons. The battery muſt alſo be provided with carriages, and other implements, neceſſary to remount the pieces, which the enemy ſhould chance to diſmount.

To ſerve expeditiouſly and ſafely a piece in battery, it is neceſſary to have to each a ſack of leather, large enough to contain about twenty pounds of powder to charge the lanterns or ladles, without carrying them to the magazine; and to avoid thereby making thoſe trains of powder in bringing back the lantern from the magazine, and the accidents which frequently happen thereby.

A *battery* of 3 pieces, muſt have 30 gabions, becauſe ſix are employ'd on each of the two ſides or epaulments, which make twelve, and nine for each of the two merlons.

There ought to be two gunners and ſix ſoldiers to each piece, and four officers of artillery.

The gunner poſted on the right of the piece, muſt take care to have always a pouch full of powder, and two priming-irons; his office is to prime the piece, and load it with powder. That on the left, fetches the powder from the little magazine, and fills the lanthern or ladle which his comrade holds; after which he minds that the match be very well lighted, and ready to ſet fire to the piece at the firſt command of the officer.

There muſt be three ſoldiers on the right, and three on the left of the piece. The two firſt to take care to ram, and ſpunge the piece, each on his ſide. The rammer and ſpunge muſt be placed on the left, and the lantern or ladle on the right. After having rammed well the wad put over the powder, and that put over the bullet, they then take each a handſpike, which they paſs between the foremoſt ſpokes of the wheel, the ends whereof will paſs under the head of the carriage, to make the wheel turn round, leaning on the other end of the handſpike, towards the embraſure.

It is the office of the ſecond ſoldier on the right, to provide wad, and to put it into the piece, as well over the powder as over the bullet; and that of his comrade on the left, to provide 50 bullets, and every time the piece is to be charged, to fetch one of them, and put it into the piece, after the powder has been rammed. Then they both take each an handſpike, which they paſs under the hind part of the wheel, to puſh it in *battery*.

The officer of artillery muſt take care to have the piece diligently ſerved.

In the night he muſt employ the gunners and ſoldiers, who ſhall relieve thoſe who have ſerved 24 hours, to repair the embraſures.

If there be no water near the *battery*, care muſt be taken to have a caſk filled with it, to dip the ſpunges in it, and cool the pieces, every ten or twelve rounds.

The MORTAR is a ſhort piece of ordnance, thick and wide, proper for throwing bombs, carcaſſes, ſhells, ſtones, *&c.*

There are chiefly two kinds of *mortars*: the one hung or mounted on a carriage with low wheels, after the manner of guns, called *pendent* or *hanging mortars*; the other fix'd on an immoveable baſe, called *ſtanding mortars*. See the *Plate* GUNNERY.

At the head of the bore, or chaſe of the *mortar*, is the chamber for the charge of the powder. This is uſually made cylindrical, all but the baſe which they make hemiſpherical: though ſome of the later engineers prefer hemiſpherical chambers; as the ſurface of thoſe being leſs, under equal capacities, make leſs reſiſtance to the gun-powder.

The

The thickneſs of the *mortar* about the chamber, is to be much greater than about the chaſe, by reaſon the gun-powder makes a much greater effort about the chamber than elſewhere. The diameter of the chamber to be much leſs than that of the bore; by reaſon bombs, ſhells, *&c.* are much lighter than the bullets of equal diameters, and conſequently leſs powder ſuffices.

The firſt *mortar-piece* uſed for throwing ſtones, weighs commonly 1000 *lb.* and whoſe utmoſt random is 150 fathoms, loaded with two pounds of powder, it has 15 inches of diameter at its mouth, and 2 foot 7 inches in height.

The depth of its bore or chaſe is 1 foot 7 inches, and the depth of its chamber, without including the entrance where the tampion is placed, 8 inches. The tourillons have 5 inches of diameter.

The chamber muſt enter an inch into the tourillons. The thickneſs of the metal about the chamber, 3 inches; the thickneſs of the belly, 2 inches; and the length of the chaſe, 1 inch and ½; about each ring, 1 inch and ¼.

Mortars, for throwing bombs, are of ſeveral kinds.

There are ſome, in the antient manner, of 6, 7, 8, 9, 10, 11, 12, and 18 inches diameter at their mouth, and which contain in their chambers, 3, 4, 5, 6, and 12 pounds of powder.

The chamber where the powder is put is cylindrical, *i. e.* of the ſame breadth every where, and a little rounded at bottom.

Thoſe of new invention, have a concave chamber. And of theſe there are ſome which have 12 inches and ¾ at the mouth, and contain in their chambers 18 pounds of powder; others 12, and others 8.

The proportions of *mortars* are as follow. The *mortar* which throws a bomb of 17 inches 10 lines of diameter, has the bore 27 ½ inches long, and 18 inches 4 lines of diameter: it has in thickneſs between the bourelet, and its ſmall reinforced ring, 3¼ inches; its ſmall reinforced ring, is 3¼ inches thick; its great one, 4 inches; the entrance of its chamber has 5½ inches of diameter; the chamber, in form of a pear, is 13 inches long, and 7½ inches of diameter at its greateſt breadth; and alſo 7½ thick, and contains 12 pounds of powder.

The tourillons of the *mortar* have 32 inches in length from one end to the other, and 9 of diameter. The *mortar* has in height 4 foot 4 inches.

The *bomb* has 17 inches 10 lines of diameter, is 2 inches thick every where, except the bottom, which has 2 inches 10 lines. The aperture of the touch-hole is of 20 lines within and without.

The *bomb* contains 48 *lb.* of powder, and weighs 490 *lb.* and a little more.

The bore of the *concave mortar*, whoſe chamber contains 18 pounds of powder, has 12½ inches of diameter, and is 18½ inches long. It has in thickneſs, between the bourrelet, and its reinforced ring, 3½ inches; and its reinforced ring is 4½ inches thick. Its chamber has 9 inches 7 lines of diameter at its greateſt width: the higher part thereof has 6 inches of diameter, and 4 inches in height; and its lower part 2½ inches. The thickneſs of the metal round the chamber is of 26 inches 9 lines. The tourillons have from one end to the other 8 inches of diameter. The mortar has in height 3 feet 5 inches 4 lines. It throws a bomb of 11 inches 8 lines diameter, which is 1 inch 4 lines thick every where, except at its *cullot*, which has 1 inch 8 lines. The aperture of its touch-hole is 16 lines inſide and outſide. The bomb contains 15 pounds of powder, and weighs 130 pounds, or thereabout.

The bore or chaſe of the *concave mortar*, whoſe chamber contains 12 pounds of powder, has 12 inches 6 lines of diameter, and 17 inches 6 lines in length. Its thickneſs between the bourrelet and its reinforced ring, is of 2½ inches. Its reinforced ring is 3 inches thick. Its chamber has of diameter at its greateſt width, 9 inches 6 lines. The portion of that chamber a-top has 5 inches 4 lines of diameter, and 2 inches at bottom. The thickneſs of the metal round the chamber is 6 inches. The tourillons are from one end to the other, 30 inches long, and 7 inches of diameter; and the mortar is in all 3 foot 2 inches high.

It throws a bomb, 11 inches 8 lines of diameter, which is 1 inch 4 lines thick every where, except at its cullot, which has 1 inch 8 lines.

The aperture of its touch-hole, outſide and inſide, is 16 lines.

The bomb contains 15 *lb.* of powder, and weighs 130.

The *mortar*, which has a concave chamber containing 8 pounds of powder, muſt throw a bomb of 11 inches 8 lines.—Its diameter is of 12½ inches; its bore 18 inches long; its thickneſs at the chaſe 2½ inches; its reinforced ring 6 inches long, and 3 inches thick; its concave chamber 8 inches 8 lines long, and 7 inches in diameter; the thickneſs of the metal round it 5 inches; its tourillons 3 inches long from one end to the other, and 7 inches in diameter.—The concave chamber contains 8 pounds of powder, and throws a bomb as above.

The *ordinary mortar*, which throws a bomb of 11 inches 8 lines, has a bore of 12 inches diameter, and 18 long; its thickneſs at the neck 2 inches; at its reinforced ring 2½ inches. its chamber 9½ inches in length, its diameter of 5 ½ inches, the thickneſs of the metal round the chamber 7 inches, which chamber contains 6 pounds of powder; the

tourillons

tourillons have in length from one end to the other 28 inches, and 8 inches of diameter.

The *mortar*, which throws a bomb of 8 inches, has the bore 12 inches long, and 8 inches 4 lines in diameter; its thickneſs 1 inch 4 lines at the chaſe; its reinforc'd rings 4 inches 8 lines long, and 1 inch 8 lines thick; its chamber 6 inches long, and 2 inches 8 lines of dameter; its tourillons 18 inches 8 lines in length, and 4 inches 8 lines of diameter.—The bomb of 8 inches of diameter is 10 lines thick every where, except at the cullot, which is 13, and its touch-hole 1 inch of diameter inſide and outſide. The chamber contains 4 pounds of powder, and the bomb weighs 40 lb.

The bore of the mortar, which is to throw a bomb of 6 inches, is of 6 ¼ inches of diameter, and 9 inches long; its thickneſs at the chaſe 1 inch; its reinforced ring 1 ½ inch thick, and 3 ¼ inches long; its chamber 4 ¼ inches long, and 2 inches of diameter; the thickneſs of the metal 2 inches, and from the bottom of the chamber to behind the recoil of the mortar 4 inches thick.

That common *mortars* are very good for the bombardment of a place, when they can be carried near the place; throwing the bomb to 45 degrees of elevation, and to 700 fathoms diſtance: the chamber charged with 5 or 6 pounds of powder, which is the greateſt charge, and carries further: the nearer a place a mortar is mounted, the leſs powder is wanted for its charge. The *mortars* with a concave chamber of the ſame diameter, *i. e.* of 12 and 12 ½ inches pointed at 45 degrees, are proper to bombard places afar off; they carry their bombs from 1200 to 1800 fathoms. Thoſe whoſe chamber contains 8 pounds of powder throw the bomb to 1200 fathoms, and weigh 2000 *lb.* Thoſe of 12 pounds of powder will carry their bombs to 1400 fathoms, and weigh 2500 *lb.* Thoſe of 18 pounds of powder will carry to 1800 fathoms, and weigh 5000 *lb.*

The *carriage* for a mortar of 12 inches of diameter muſt be 6 foot long, the flaſks 12 inches long, and 10 thick. The trunnions are placed in the middle of the *carriage*.

The *carriage* of 18 muſt be 4 foot long; and the flaſks 11 inches high, and 6 thick.

To mount the *mortars* of new invention, they uſe *carriages* of caſt iron.

In *Germany*, to mount *mortars* from 8 to 9 inches, and carry them into the field, and execute them horizontally as a piece of cannon, they make uſe of a piece of wood 8 feet 2 inches long, with a hole in the middle to lodge the body of the *mortar* and its trunnions as far as their half diameter, and mounted on two wheels four feet high, to which they join a vantrain proportioned to it, and made like thoſe which ſerve to the cariages of cannons

Having mounted our *mortars* on its carriage, the next thing we do we'll *caliber* our bomb, by means of a great *caliper*, (See the plate of *Gunnery*) the two branches whereof embrace the whole circumference of the bomb: Theſe two branches are brought on a rule where the different calibers are marked, among which that of the bomb is found.

A *bomb* is a hollow iron ball, or ſhell filled with gunpowder, and furniſhed with a vent for a fuſee or wooden tube filled with combuſtible matter to be thrown out from a mortar. The method of preparing a bomb is as follows: A hollow iron globe is caſt pretty thick, having a round aperture by which it may be filled and lighted; and circular anſæ for the commodious putting it into the mortar. To prove whether it be ſtaunch, after heating it red hot on the coals, it is expoſed to the air, ſo as it may cool gently; for ſince fire dilates iron, if there be any hidden chinks or perforations, they will thus be opened enlarged; and the rather becauſe of the ſpring of the included air continually acting from within. This done, the cavity of the globe is filled with hot water, and the aperture well ſtopped, and the outer ſurface waſhed with cold water and ſoap; ſo that if there be the ſmalleſt leak, the air, rarified by the heat, will now perſpire and form bubbles on the ſurface.

If no defect be found in the bomb, its cavity is filled, by means of a funnel, with whole gunpowder; a little ſpace or liberty is left, that when a fuſee or wooden tube, of the figure of a truncated cone, is driven through the aperture (with a wooden mallet not an iron one, for fear of accident) and faſtened with a cement made of quick lime, aſhes, brick-duſt, and ſteel-filings worked together in a glutinous water, or of four parts of pitch, two of colophony, one of turpentine, and one of wax; the powder may not be bruiſed. This tube is filled with a combuſtible matter, made of two ounces of nitre, one of ſulphur, and three of gunpowder-duſt well rammed.

This fuſee ſet on fire, burns ſlowly till it reaches the gunpowder, which goes off at once, burſting the ſhell to pieces with incredible violence. Special care however muſt be taken, that the fuſee be ſo proportioned, as that the gunpowder do not take fire ere the ſhell arrives at the deſtined place; to prevent which, the fuſee is frequently wound round with a wet clammy thread.

Our *mortar* mounted on its carriage, and the bomb ready, we'll place our piece in battery, which battery muſt conſiſt; — 1. Of an epaulment to ſhelter the *mortars* from the fire of the enemy. 2. Of platforms on which the *mortars*

are

are placed. 3. Of ſmall magazines of powder. 4. Of a boyau which leads to the great magazines 5. Of ways which lead from the battery to the magazine of bombs. 6. Of a great ditch before the epaulment. 7. Of a berm or retraite. See page 507, 508.

The platforms for mortars of 12 inches muſt have 9 feet in length, and 6 in breadth. — The *lambeurds* for common mortars muſt be 4 inches thick; thoſe of a concave chamber of 8 *lb.* of powder, 5 inches; thoſe of 12 *lb.* 6 inches; thoſe 18 *lb.* 7 inches, or thereabouts. Their length is at diſcretion, provided there be enough to make the platforms 9 feet long.—The fore-part of the plat-form will be ſituated at two foot diſtance of the epaulment of the battery. — The bombardiers, to ſhelter themſelves in their battery, and not be ſeen from the town beſieged, raiſed an epaulment of 7 foot or more high, which epaulment has no embraſures.

To ſerve expeditiouſly a mortar in battery are required, — five ſtrong *handſpikes*, a *dame* or *rammer*, of the caliber of the conick chamber, to ram the wad and the earth, a wooden knife a foot long to place the earth round the bomb, an iron ſcraper two foot long, one end whereof muſt be 4 inches broad and roundwiſe to clean the bore, and the chamber of a mortar, and the other end made in form of a ſpoon to clean the little chamber, a kind of *brancard* to carry the bomb, a ſhovel, and pick-ax.

The officer who is to mind the ſervice of the mortar muſt have a quadrant to give the degrees of elevation.

Five *bombardiers*, or others are employed in that ſervice; the firſt muſt take care to fetch the powder to charge the chamber of the mortar, putting his priming-iron in the touch-hole before he charges the chamber; and never going to fetch the powder before he has aſked his officer at what quantity of powder he deſigns to charge, becauſe more or leſs powder is wanted according to the diſtance where it is fired; the ſame will take care to ram the wad and earth which another ſoldier ſhall put in the chamber.

That on the right will put again two ſhovels full of earth in the bottom of the bore, which ſhould be likewiſe very well rammed down.

This done the *rammer* or *dame* ſhall be returned into its place againſt the epaulment on the right of the mortar: he'll take an handſpike in the ſame place to poſt himſelf behind the carriage of the mortar, in order to help to puſh it into battery; having laid down his handſpike, he'll take out his priming-iron, and prime the touch-hole with fine powder.

The ſecond ſoldiers on the right and left, will have by that time brought the bomb ready loaded, to be placed in the mortar, which muſt be received in the mortar by the firſt ſoldier, and placed very ſtrait in the bore or chaſe of the mortar.

The firſt, on the right, ſhall furniſh him with earth to put round the bomb, which he muſt take care to ram cloſe with the knife given him by the ſecond on the left.

This done, each ſhall take a handſpike, which the two firſt, on the right and left, ſhall put under the pegs of retreat of the fore part, and the two behind, under thoſe of the hind-part; and they together ſhall puſh the mortar in battery.

Afterwards the officer ſhall point or direct the mortar.

During that time the firſt ſoldier ſhall take care to prime the touch-hole of the mortar, without ramming the powder; and the laſt on the right, ſhall have the match ready to ſet fire on the fuſee of the bomb on the right, while the firſt ſhall be ready with his on the left, to ſet fire to the touch-hole of the mortar; which he ought not to do till he ſees the fuſee well lighted.

The foremoſt ſoldiers will have their handſpikes ready to raiſe the mortar upright, as ſoon as it has diſcharged; while the hindmoſt on the left ſhall, with the ſcraper, clean the bore and chamber of the mortar.

The *magazine* of powder for the ſervice of the battery, ſhall be ſituated 15 or 20 paces behind, and covered with boards, and earth over it. — The loaded bombs are on the ſide of the ſaid magazine, at 5 or 6 paces diſtance.

The officer who commands the ſervice of the mortar, muſt take care to diſcover, as much as poſſible with the eye, the diſtance of the place where he intends to throw his bomb, giving the mortar the degrees of elevation, according to the judgment he has formed of the diſtance. Having thrown the firſt bomb, he'll diminiſh or increaſe the degrees of elevation, according to the place upon which it ſhall fall. Several make uſe of *tables* to diſcover the different diſtances according to the differences of the elevations of the mortar, eſpecially the degrees of the quadrant from 1 to 45.

M. *Blondel* has wrote a large treatiſe on that ſubject, where he pretends to give a demonſtration to throw bombs with great exactneſs.

They ſay then (ſays M. *Blondel* ſpeaking of *bombardiers*) that the mortars chaſe more or leſs, according as it is more or leſs charged with powder; and that a mortar, for example, of 12 inches caliber, charged in its chamber with 2 lb. of powder, gives every degree 48 feet difference in the random, and for the greateſt extent under the elevation of 45 degrees, 2160 feet.

The

The ſame mortar will give every degree 50 foot difference, if it be charged with 2¼ of the ſame goodneſs, and 2700 foot for the greateſt random.

Laſtly, it will give 72 foot difference every degree, if the charge be of 3 *lb.* of the ſame powder, and at the elevation of 45 degrees, which, they ſay, is the greateſt random, it will throw the bomb at the diſtance of 3240 foot.

On this foundation they have made the following tables.

TABLES *for* Mortars *of* 12 *inches of* Caliber.

Firſt Table at 2 *pounds* of *powder*.

Degrees	*Randoms*	*Degrees*	*Randoms*
5	240 *Feet*	28	1344 *Feet*
10	480	29	1392
11	528	30	1440
12	576	31	1488
13	624	32	1536
14	672	33	1584
15	720	34	1632
16	768	35	1680
17	816	36	1728
18	864	37	1776
19	912	38	1824
20	960	39	1872
21	1008	40	1920
22	1056	41	1968
23	1104	42	2016
24	1152	43	2064
25	1200	44	2112
26	1248	45	2160
27	1296		

Note, That the difference is of 48 feet every degree.

Second Table at *two pounds* and *half* of *powder*.

Degrees	*Randoms*	*Degrees*	*Randoms*
36	2160 *Feet*	41	2460 *Feet*
37	2200	42	2520
38	2280	43	2580
39	2340	44	2640
40	2400	45	2700

Note, That the difference is of 60.

Third Table at *three pounds* of *powder*.

Degrees	*Randoms*	*Degrees*	*Randoms*
37	2664 *Feet*	42	3024 *Feet*
38	2736	43	3096
39	2808	44	3168
40	2880	45	3240
41	2952		

The difference is of 72.

TABLES *for* mortars *of eight inches* caliber.

Firſt table at *half pound* of *powder*.

Degrees	*Randoms*	*Degrees*	*Randoms*
5	210 *Feet*	28	1176 *Feet*
10	420	29	1218
11	460	30	1260
12	504	31	1302
13	546	32	1344
14	588	33	1386
15	630	34	1428
16	672	35	1470
17	714	36	1512
18	756	37	1554
19	798	38	1596
20	840	39	1638
21	882	40	1680
22	924	41	1722
23	966	42	1764
24	1008	43	1806
25	1050	44	1848
26	1092	45	1890
27	1134		

The difference is of 42 feet every degree.

Second table at *three quarters* of a *pound* of *powder*.

Degrees	*Randoms*	*Degrees*	*Randoms*
31	1922 *Feet*	39	2418 *Feet*
32	1984	40	2480
33	2046	41	2542
34	2108	42	2604
35	2170	43	2666
36	2232	44	2728
37	2294	45	2790
38	2356		

The difference is of 62.

Third table at *one pound* of *powder*.

Degrees	*Randoms*	*Degrees*	*Randoms*
35	2870 *Feet*	41	3362 *Feet*
36	2952	42	3444
37	3034	43	3526
38	3116	44	3608
39	3198	45	3690
40	3280		

Granadoes are charged like the *bombs*, and are very much like them, except that they have no *anſæ*.

A GRANADO, (*ibid*) is a hollow ball, or ſhell of iron, braſs, or even glaſs, or potters earth, filled with gun-powder, and fitted with a fuſee to give it fire.

Of these there are several kinds, the one large for ditches, or fossees, called sometimes bombs, whose caliber is the same with that of the bullets of 33 *lb.* and which weigh 16 *lb.* of 24, and which weigh 12 *lb.* of 16, which weigh 8 *lb.*

Those *Granadoes* are rolled from the ramparts, or other works into the ditch, or on a breach, and do much execution.

The other are *hand-granadoes*, of the bigness or caliber of a bullet of 4 *lb.* and weigh only 2 *lb.* containing 4 or 5 ounces of powder, or thereabout.

These serve to throw with the hand into the trenches, or retrenchments, in the middle of a troop or company, and they infallibly lame or kill.

Care is taken, as much as possible, that they be well emptied, shaved, and of brittle iron. Their aperture or orifice, must have six lines, or thereabout.

Small lanterns or ladles of copper, and small rammers are used to charge the *granadoes*.

As to the proportions of *granadoes*, those of the caliber of a bullet of 33, have 6 inches of diameter, and something more, they are 8 lines thick, and weigh 16 *l.*

Those of the caliber of 24, have 5 inches 5 lines diameter; are 6 lines thick, and weigh 12 *lb.*

Those of the caliber of 16, have 4 inches 9 lines of diameter, are 5 lines thick, and weigh 8 *lb.*

Those which weigh 6 *lb.* have 3 inches 5 lines diameter, and 5 lines in thickness.

Those of 5 *lb.* weight, have 3 inches 2 ½ lines diameter, and 5 lines in thickness.

Those which weigh 3 *lb.* have 2 inches 8 lines diameter, and are 4 ½ lines thick.

Those of 2 *lb.* weight, have 2 inches 4 lines diameter, and 4 lines in thickness.

Those of 1 *lb.* weight, have 1 inch 10 lines diameter, and are three lines thick.

Those of ½, have 1 inch 8 lines diameter, and are 3 lines thick.

Those of ¼, have 1 inch 6 lines diameter, and are 3 lines thick.

Those of 2 ½, have 1 inch 2 lines diameter, and are 2 ½ lines thick.

All these *granadoes* must be thicker at bottom than any where else.

These different sorts of *granadoes* have also different sorts of fusees.

Those of the caliber of,	33	24	16	12	8	4
are, at the biggest end, of	12 *lin.*	11	10½	10	9½	8½
The diameter of the orifices,	4	4	3	3	3	2
The fusees are in length, in all, of	5½ *inch.*	5	4	4	3½	2½

And as the large *granadoes*, which are made to throw into the *fossés*, or ditches, or with small mortars, they must have fusees of different lengths; these are for small mortars; those for ditches must be shorter.

The *Germans* cover over the fusee with paper or parchment, tied with a thread round the fusee.

In *France* they use a composition of black pitch, mixed with a little tallow, with which they rub over the fusee, when fixed to the *granado*.

The fusee must burn so long, and no longer, as is the time of the motion of the bomb or *granado*, from the mouth of the mortar, *&c.* to the place where it is to fall, which time is about 27 seconds; so that the fusee must be contrived, either from the nature of the composition, or the length of the pipe, which contains it, to burn just that time.

At *Paris* they charge the fusees for the bombs and *granadoes*, with a composition made with powder-dust and charcoal, very well pounded, and sifted very fine, putting two ounces of charcoal on each pound of powder, and make several proofs, to know if the composition be not too quick.

There are several other compositions to charge the fusees for bombs or *granadoes*.

The first is of 4 *lb.* of powder, 2 *lb.* of salt-petre, and 1 *lb.* of sulphur.

The second is of 5 *lb.* of powder, 2 *lb.* of salt-petre, and 1 pound of sulphur.

The third, which is the best, is of 3 *lb.* of powder, 2 *lb.* of salt-petre, and 1 *lb.* of sulphur.

The fourth is of 3 *lb.* of powder, 2 *lb.* of salt-petre, and ½ *lb.* of sulphur.

The fusees must be charged even, *i. e.* they must burn without spitting.

The fusee of the hand-granado, which is of the caliber of 4, must be 2 inches 2 lines long, 9 lines of diameter, and 6 lines at the small end: the orifice of the fusee 2½ lines.

As soon as the fusee is placed to the *granado*, the head thereof must be sauced in melted pitch, and afterwards dipped in water, which hinders the composition from spoiling, and the wood from rotting.

The Petard (*ibid.*) is the next piece of artillery, which deserves our attention, and is a kind of engine of metal, somewhat in shape of a high-crown'd hat, serving to break down gates, barricades, draw-bridges, or the like works; which are intended to be surprized. It is very short, narrow at the breech, and wide at the muzzle, made of copper mix'd with a little brass, or of lead with tin.

The *petards* are not always of the same height and bigness: they are commonly 10 inches high, 7 inches of diameter a-top, and 10 inches at bottom. They weigh commonly 40, 45, and 50 pounds.

The Madrier (*ibid.*) on which the *petard* is placed, and where it is tied with iron circles, is of two feet for its greatest width, and of 18 inches on the

the ſides, and no thicker than a common *madrier*. Under the *madrier* are two iron bars paſſed croſswiſe, with a hook, which ſerves to fix the *petard*.

To charge a *petard* 15 inches high, and 6 or 7 inches of caliber or diameter at the bore, the inſide muſt be firſt very well cleaned and heated, ſo that the hand may bear the heat; then take the beſt powder that may be found, throw over it ſome ſpirit of wine, and expoſe it to the ſun, or put it in a frying-pan, and when it is well dried, 5 or 6 *lb.* of this powder is put into the *petard*, which reaches within three fingers of the mouth: the vacancies is filled with tow, and ſtopped with a wooden tampion; the mouth being ſtrongly bound up with cloth tied very tight with ropes; then it is fixed on the *madrier*, that has a cavity cut in it to receive the mouth of the *petard*, and faſtened down with ropes.

Some, inſtead of gun-powder for the charge, uſe one of the following compoſitions, *viz.* gun-powder ſeven pounds, mercury ſublimate one ounce, camphor eight ounces; or gun-powder ſix pounds, mercury ſublimate three ounces, and ſulphur three; or gun powder ſix, beaten glaſs $\frac{1}{2}$ an ounce, and camphor $\frac{1}{4}$.

What has been ſaid of the art of charging and directing of *cannons*, may be properly illuſtrated by a few problems in the doctrine of *projectiles*: for, as an author of great repute in this ſubject obſerves, it is only the great importance of *Gunnery*, that makes it a diſtinct doctrine from *projectiles* in general; it being no more than an application of thoſe laws, which all bodies obſerve, when caſt into the air, to ſuch as are put in motion by the exploſion of guns or other engines of that ſort. And it is the ſame thing whether it is treated in the manner of *projectiles* in general, or of ſuch only as belong to *gunnery*; for, from the moment the force is impreſſed, all diſtinction with regard to the power, which put the body firſt in motion, is loſt, and it can only be conſidered as a ſimple *projectile*.

Prob. I. The impetus of a ball, and the horizontal diſtance of an object aimed at, with its perpendicular height or depreſſion, if thrown on aſcents or deſcents, being given, to determine the direction of that ball.

From the point of projection A draw A*m* repreſenting the horizontal diſtance, and B*m* the perpendicular height of the object aimed at: biſect A*m* in H, and AH in *f*; on H and *f* erect HT, *f*F perpendicular to the horizon, and biſecting AB the oblique diſtance or inclined plane in D, and AD in F. On A raiſe the impetus AM at right angles with the horizon, and biſect it perpendicularly in *c*, with the line GG. Let the line AC be normal to the plane of projection AB, and cutting GG in C; from C as center, with the radius CA, deſcribe the circle AGM cutting if poſſible the line FS in S, *s*, points equally diſtant from G;

FIG. 5.

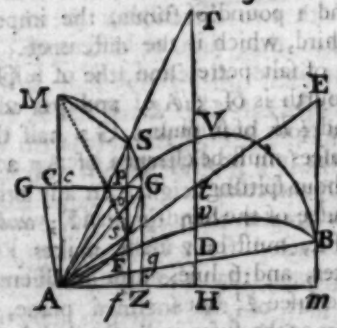


FIG. 6.

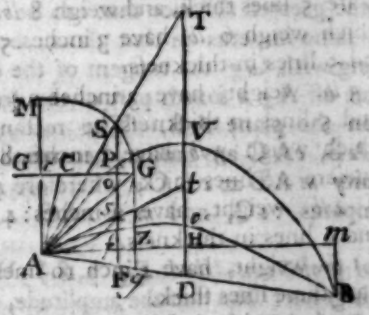


FIG. 7.

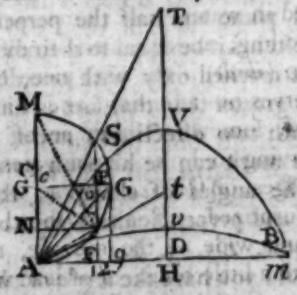
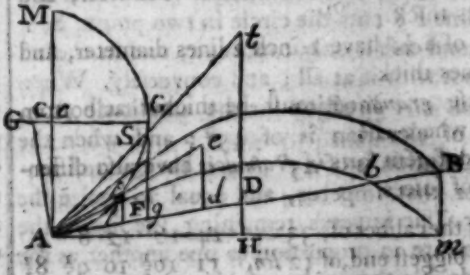


FIG. 8.



lines

lines drawn from A through S, *s* will be the tangents or directions required.

Continue A S, A *s* to T, *t*; biſect D T, D *s*, in V *v*; and draw lines from M to S, *s*; then the ∠ A S F = ∠ M A S = ∠ A M *s* = ∠ *s* A F; and for the ſame reaſon ∠ A *s* F = ∠ M A *s* = ∠ A M S = ∠ S A F; wherefore the triangles M A S, S A F, *s* A F are ſimilar, and A M : A *s* :: A *s* : *s* F = *t v*; conſequently A T is a tangent of the curve paſſing through the points A, *v*, and B; becauſe *t v* = *v* D, A D is an ordinate to the diameter T H, and where produced muſt meet the curve in B.

In horizontal caſes (*Fig.* 7.) *v* is the higheſt point of the curve, becauſe the diameter T *v* H is perpendicular to the horizon.

When the mark can be hit with two directions (the triangles S A M, *s* A F being ſimilar) the angle which the loweſt direction makes with the plane of projection is equal to that which the higheſt makes with the perpendicular A M, or ∠ *s* A F = ∠ S A M. And the angle S A *s*, comprehended between the lines of direction, is equal to the angle S C G, and is meaſured by the arch S G.

When the points S, *s* coincide with G, or when the directions A S, A *s* become A G; (*Fig.* 8.) A B will be the greateſt diſtance that can be reached with the ſame impetus on that plane; becauſe S F coinciding with G *g* the tangent of the circle at G, will cut off A *g* a fourth part of the greateſt amplitude on the plane A B. The rectangular triangles *m* A B, *c* A C are ſimilar, becauſe the angle of obliquity *m* A B = *c* A C; wherefore *m* A : *m* B :: ¼ impetus : *c* C, and *m* A : A B :: A *c* : A C.

Horizontal projections (*ibid. Fig.* 7, 8.) When the impetus is greater than half the amplitude, there are two directions, T A H, and *t* A H for that amplitude; when equal to it, only one; and when leſs, none at all; and converſely. For in the firſt caſe the line F S cuts the circle in two points S, *s* in the ſecond caſe it only touches it, and in the laſt it meets not with it at all; and converſely. When there is but one direction for the amplitude A *m*, the angle of elevation is of 45°; and when the angle of elevation is of 45° A *m* is the greateſt amplitude for that impetus, and equal to twice the impetus. The impetus remaining the ſame, the amplitudes are in proportion to one another as the ſines of double the angles of elevation, and converſely. For drawing *s* N (*Fig.* 7.) parallel and equal to A F a fourth part of the amplitude, and ſuppoſing lines drawn from *s* to the points C and M; the angle A C *s* = 2 A M *s* = 2 *s* A F; therefore N *s* the ſine of A C *s*, is the ſine of twice the angle *s* A F, half the impetus being radius.

Whence, at the directions of 15° or 75° the amplitude is equal to the impetus; for from what has been ſaid, half the impetus being radius, a fourth part of the amplitude is the ſine of twice the angle of elevation; but the ſine of twice 15°, that is, the ſine of 30°, is always equal to half the radius; or in this caſe a fourth part of the impetus is equal to a fourth part of the amplitude.

From this and the preceding *prop.* there are two eaſy practical methods for finding the impetus of any piece of ordnance. The fourth part of the amplitude is a mean proportional between the impetus at the curve's principal vertex and its altitude. For M N : N *s* :: N *s* : N A = *s* F = *v* D.

The altitudes are as the verſed ſines of double the angles of elevation, the impetus remaining the ſame. For making half the impetus radius, A N the altitude is the verſed ſine of the angle A C *s* = twice ∠ *s* A F. And alſo, radius : tangent ∠ elevation :: ¼ amplitude : altitude, that is, R : tangent ∠ *s* A *f* :: A *f* : *f s* = D *v*.

Projections on aſcents and deſcents, Fig. 5. 6.

If the mark can be hit only with one direction A G, the impetus in aſcents will be equal to the ſum of half the inclined plane and half the perpendicular height, and in deſcents it will be equal to their difference; but if the mark can be reached with two directions, the impetus will be greater than that ſum or difference. For when A G is the line of direction, the ∠ *g* G A being = M A G = G A *g*; G *g* = A *g*, and *gz* added to or ſubtracted from both makes G *z* half the impetus equal to the ſum or difference of A *g* a fourth part of the perpendicular height. In any other direction F P is greater than F *o* = A F; and F *f* added to or ſubtracted from both, makes *f* P half the impetus greater than the ſum or difference of A F a fourth part of the inclined plane, and F *f* a fourth part of the perpendicular height. Whence if in aſcents the impetus be equal to the ſum of half the inclined plane and half the perpendicular height, or if in deſcents it be equal to their difference, the mark can be reached only with one direction; if the impetus is greater than that ſum or difference, it may be hit with two directions; and if the impetus is leſs, the mark can be hit with none at all.

Prob. II. The angles of elevation, the horizontal diſtance, and perpendicular height be given, to find the impetus. *Fig.* 5. 6.

From theſe data you have the angle of obliquity, and length of the inclined plane; then as A *s* : A M :: S. ∠ A M *s* : S. ∠ A *s* M :: S. ∠ *s* A F : S. ∠ M A F and A F : A *s* :: S. ∠ M A *s* : S. ∠ M A F; whence by the ratio of equality, A F : A M :: S. ∠ *s* A F × S. ∠ M A *s* : S. ∠ M A F × S. ∠ M A F, which gives this rule. A

Add the log. of AF to twice the logarithmic ſine of the angle MAF; from their ſum ſubtract the logarithmic ſines of the angles *s* AF and MA*s*, and the remainder will give the logarithm of AM the impetus.

When the impetus and angles of elevation are given, and the length of the inclined plane is required, this is the rule. Add the log. of AM to the log. ſines of the angles *s* AF and MA*s*; from their ſum ſubtract twice the log. ſine of ∠ MAF, and the remainder will give the log. of AF the fourth part of the length of the inclined plane.

If the angle of elevation *t* AH and its amplitude AB (*Fig.* 8.) and any other angle of elevation *t* AH is given; to find the amplitude A*b* for that other angle, the impetus AM and angle of obliquity DAH remaining the ſame.

Deſcribe the circle AGM, take AF a fourth part of AB, and A*f* a fourth part of A*b*: from the points F, *f*, draw the lines F*s* and *f p* parallel to AM, and cutting the circle in the points *s*, *p*; then AF : AM :: S. ∠ *s* AF × S. ∠ MA*s*; S. ∠ MAF × S. ∠ MAF; and AM : A*f* :: S. ∠ MAF × S. ∠ MAE : S. ∠ *p* A*f* × S. ∠ *p* AM; whence by the ratio of equality.

AF : A*f* :: S. ∠ *s* AF × S. ∠ MA*s* : S. ∠ *p* A*f* × S. ∠ *p* AM, which gives this rule.

Add the log. of AF to the log. ſines of the angles *p* A*f*, *p* AM; from their ſum ſubtract the log. ſines of the angles *s* AF, *s* AM, and the remainder will give the log. of A*f*, a fourth part of the amplitude required.

Prob. III. To find the force or velocity of a ball or projectile at any point of the curve, having the perpendicular height of that point, and the impetus at the point of projection given. From theſe two data find out the impetus at that point; then 2 × 16 feet 1 inch is the velocity acquired by the deſcent of a body in a ſecond of time; the ſquare of which (4 × □ 16 feet 1 inch) is to the ſquare of the velocity required, as 16 feet 1 inch is to the impetus at the point given; wherefore multiplying that impetus by four times the ſquare of 16 feet 1 inch, and dividing the product by 16 feet 1 inch, the quotient will be the ſquare of the required velocity; whence this rule. Multiply the impetus by four times 16 feet 1 inch, or 64 feet ⅓, and the ſquare root of the product is the velocity.

Thus ſuppoſe the impetus at the point of projection to be 3000, and the perpendicular height of the other point 100; the impetus at that point will be 2900. Then 2900 feet multiplied by 64 ⅓ feet gives 186566 feet, the ſquare of 432 nearly, the ſpace which a body would run through in one ſecond, if it moved uniformly.

And to determine the impetus or height, from which a body muſt deſcend, ſo as at the end of the deſcent it may acquire a given velocity, this is the rule:

Divide the ſquare of the given velocity (expreſſed in feet run through in a ſecond) by 64 ⅓ feet, and the quotient will be the impetus.

The duration of a projection made perpendicularly upwards, is to that of a projection in any other direction whoſe impetus is the ſame, as the ſine complement of the inclination of the plane of projection (which in horizontal projections is radius) is to the ſine of the angle contained between the line of direction and that plane.

Draw out A *t* (*Fig.* 5.) till it meets *m* B continued in E, the body will reach the mark B in the ſame time it would have moved uniformly through the line A E; but the time of its fall through M A the impetus, is to the time of its uniform motion thro' A E, as twice the impetus is to A E. And therefore the duration of the perpendicular projection, being double the time of its fall, will be to the time of its uniform motion through A E, as four times the impetus is to A E; or as A E is to E B; that is, as A *t* is to *t* D; which is as the ſine of the angle *t* DA (or M A B its complement to a ſemicircle) is to the ſine of the angle *t* A D,

Hence the time a projection will take to arrive at any point in the curve, may be found from the following data, *viz.* the impetus, the angle of direction, and the inclination of the plane of projection: which, in this caſe, is the angle the horizon makes with a line drawn from the point of projection to that point.

Hence alſo in horizontal caſes, the durations of projections in different directions with the ſame impetus, are as the ſines of the angles of elevation. But in aſcents or deſcents their durations are as the ſines of the angles which the lines of direction make with the inclined plane. Thus, ſuppoſe the impetus of any projection were 4500 feet; then 16 feet 1 inch : 1″ :: 4500 feet : 275″ the ſquare of the time a body will take to fall perpendicularly thro' 4500 feet, the ſquare root of which is 16″ nearly, and that doubled gives 32″ the duration of the projection made perpendicularly upwards. Then to find the duration of a horizontal projection at any elevation, as 20°; ſay R : S. ∠ 20° :: 32″ : duration of a projection at that elevation with the impetus 4500. Or if with the ſame impetus a body at the direction of 35° was projected on a plane inclined to the horizon 17°, ſay as ſine 73° : ſine 18° :: 32″ : duration required.

The two following tables, at one view, give all the neceſſary caſes as well for ſhooting at objects on the plane of the horizon, with proportions for their ſolutions, as for ſhooting on aſcents and deſcents,

TABLE

TABLE I For horizontal projections. *Fig.* 7.

Cases.	Given.	Required.	Proportions.
1	AM, A*m*	*t* AH H*v*	2 : AM : A*m* :: R : S. 2 ∠ *t* AH R : T. ∠ *t* AH :: $\frac{Am}{4}$ H*v*.
2	AM, *t* AH	A*m*	R : S. 2 ∠ *t* AH :: 2 AM : A*m*.
3	A*m*, *t* AH	AM	S. 2 ∠ *t* AH : R :: $\frac{Am}{2}$: AM
4	AM, H*v*.	A*m*	$\sqrt{AN \times NM} = \frac{Am}{4}$, or $\frac{1}{2}$ Log. AN + $\frac{1}{2}$ Log. NM = Log. $\frac{1}{4}$ A*m*.
5	A*m*, H*v*	*t* AH AM	$\frac{Am}{4}$: H*v* :: R : T. ∠ *t* AH. AN : $\frac{Am}{4}$ :: $\frac{Am}{4}$: NM, and AN + NM = AM.
6	H*v*, *t* AH	A*m*	T. ∠ *t* AH : R :: H*v* : $\frac{Am}{4}$
7	*t* AH, A*m* and any other angle. any other amplitude.	any other amplitude belong. to that angle. any other angle belong. to that ampl.	S. 2 ∠ *t* AH : S. 2 any other ∠ :: A*m* : amplitude required. A*m* : any other amplitude :: S. 2 ∠ *t* AH : S. 2 ∠ required.
8	*t* AH. H*v*, any other angle. any other altitude.	any other altitude. any other angle.	V. S. 2 ∠ *t* AH : V. S. 2 any other ∠ :: H*v* : altitude required. H*v* : any other altitude :: V. S. 2 ∠ *t* AH : V. S. 2 ∠ required.

TABLE II. For projections on ascents and descents. *Fig.* 5, 6.

Cases.	Given.	Required.	Proportions.
1	AM, A*m*, B*m*, AB.	TAH. *t* AH.	A*m* : B*m* :: R : T. ∠ BA*m*, half of which added to 45°, gives ∠ GA*z*. AM : AB :: A*c* : AC = CG. T. ∠ GA*z* : R :: G*z* : A*z*, and A*z* − A*f* = *fz* = PG. CG : PG :: R : V. S. of SG, half of which added to, or taken from GA*z*, gives the higher or lower direction required.
2	TAH, *t* AH, AF	A M	Log. of AM = Log. of AF + 2 Log. S. ∠ MAF − Log. S. ∠ *s*AF − Log. S. ∠ MA*s*.
3	TAH, *t* AH, AM	AF	Log. of AF = Log. AM + Log. S. ∠ *s*AF + Log. S. ∠ MA*s* − 2 Log. S. ∠ MAF.
4	B A*m*, *t* AH, A B, and any other angle *t* AH	A*b* the amplitude for that other angle.	*Fig.* 8. Log. A*f* = Log. AF + Log. S ∠ *p*Af + Log. S ∠ *p*AM − Log. S. ∠ *s*AF − Log. S. ∠ MA*s*.
	AM, DAH	A*g*	*Fig* 5, 6. T. ∠ GA*z* : Sec. ∠ *g*A*z* :: G*z* : A*g*.

Before

Before any of theſe pieces are appropriated for ſervice, it is neceſſary to have each undergo a particular trial of its ſoundneſs, which is called a proof, to be made by or before one authorized for the purpoſe, called the *proof-maſter*.

To make a proof of the piece, a prop r place is choſen, which is to be terminated by a mount of earth very thick to receive the bullets fired againſt it, that none of them may run through it. The piece is laid on the ground, ſupported only in the middle by a block of wood. It is fired three times: the firſt with powder of the weight of the bullet and the two others with ⅓ of the weight; after which a little more powder is put in to ſinge the piece; and after this water, which is impreſſed with a ſponge, putting the finger on the touch-hole, to diſcover if there be any cracks; which done they are examined with the cat, which is a piece of iron with three graſps, diſpoſed in the form of a triangle, and of the caliber of the piece; then it is viſited with a wax candle, but it is of very little ſervice in the ſmall pieces, becauſe if they be a little long, the ſmoak extinguiſhes it immediately.

The proof of mortars is made in this manner: where there are carriages of caſt iron, the mortar is placed on one of thoſe carriages. Under that carriage is made a platform of madriers 5 or 6 inches thick, the mortar is charged with the beſt powder, and with as much of it as its chamber can contain, obſerving to leave no vacuity at the neck of the mortar, but what is neceſſary to put a little wadd over the powder, and which is rammed with the end of an handſpike, to keep the powder together as much as poſſible. A large green turf, with earth two fingers deep is put over the wad, which muſt have width enough to fill up the bottom of the mortar. This turf and earth are very well rammed down, then the bomb is placed over it as upright as poſſible, leaving a ſmall place round it, which is to be filled with clay as tight as poſſible, preſſing it between the mortar and the bomb with a pointed ſtick; and as it is not neceſſary to ſpend much powder in theſe ſort of proofs, the bomb muſt be filled with as much earth as it would contain powder.

For want of carriages of caſt iron, holes are dug in the earth, where the mortars are buried as far as the touch-hole; and in order that the mortars thus buried may find more reſiſtance, and make a greater effort, large pieces of wood in form of joiſts are put under the mortar, chuſing always the hardeſt ground, to reſiſt better the recoil of the mortar.

A fuſee for granado's is put on the touch-hole of each mortar, that the gunner may have time to retire, in caſe the mortar was to burſt in the proof; which is alſo practiſed in the proof of the pieces.

This proof is made three times, without increaſing or diminiſhing any thing.

Beſides the large pieces mention'd throughout this treatiſe, invented for the deſtruction of mankind, there are others called ſmall guns, *viz. muſkets of ramparts*, *common muſkets*, *fuſi's*, *carabines*, *muſketoons*, and *piſtols*.

A *muſket*, or *muſquet*, is a fire-arm borne on the ſhoulder, and uſed in war, formerly fir'd by the application of a lighted match, but at preſent with a flint and lock.

The *common muſkets* are of the caliber of 20 leaden balls to the pound, and receive balls from 22 to 24: its length is fix'd to 3 feet 8 inches from the muzzle to the touch-pan.

A *fuſil*, or *fire-lock*, has the ſame length and caliber; and ſerves at preſent inſtead of a muſket,

A *carabine* is a ſmall ſort of fire-arm, ſhorter than a fuſil, and carrying a ball of 24 in the pound, borne by the light-horſe, hanging at a belt over the left ſhoulder.

The *carabine* is a kind of medium between the piſtol and the muſket; and bears a near affinity to the arquebuſs, only that its bore is ſmaller. It was formerly made with a match lock, but of late only with a flint lock.

The *muſquetoon* is of the ſame length of the carabine, the barrel poliſhed, and clean within.

The *muſquetoon* carries five ounces of iron, or ſeven and a half of lead, with an equal quantity of powder.

The barrel of a piſtol is generally 14 inches long.

As to the invention of *cannon* and *gun powder*, we are certain that they are diſcoveries of a modern date: but there is no depending upon the various accounts given of them by authors. All that can be ſaid with certainty is, that there is mention made of gun-powder, in the regiſter of the chamber of accounts in *France*, in the year of Chriſt 1338. That *Alphonſus* XI. king of *Caſtile*, beſieged the *Moors* with iron mortars, in the year of Chriſt 1343, and that our king *Edward* in 1346, firſt carried thoſe thundering machines of war and death into *France*, where he availed himſelf of five or ſix pieces of cannon at the battle of *Creſſi*; which after ages remember with ſo much honour to *England*.

Before the invention of theſe inſtruments of war, the ancients made uſe of the Aries, or *Battering-ram*, the *Catapultæ*, the *Balliſta*, *Scorpion*, and *Teſtudo*.

The ARIES, or *battering ram*, was an engine with an iron head, to batter and beat down the walls of places beſieged.

Of this there were two kinds; the firſt, ſimple and plain, the other artificial and compound.

The

The firſt ſeems to have been no more than a *great beam*, which the ſoldiers bore in their arms, and with an end of it, by main force, aſſailed the walls.

The ſecond, or *compound ram*, is deſcribed by *Joſephus*, (*de excid. Hieroſol.* 3.) thus: 'The *ram* 'is a vaſt long beam like the maſt of a ſhip, 'ſtrengthned at one end with a head of iron, ſome-'thing reſembling that of a ram, whence it took 'its name. This is hung by the middle with ropes 'to another beam, which lies acroſs a couple of 'poſts, and hanging thus equally balanced, is by 'a great number of men violently thruſt forwards, 'and recoiled backwards, and ſo ſhake the wall 'with its iron head, nor is there any tower or 'wall ſo thick or ſtrong, as to reſiſt the repeated 'aſſaults of this forcible machine.'

M. *Fellibien* deſcribes another ſort of *battering ram*, which runs on wheels, and was the moſt perfect and effectual of them all.

Vitruvius affirms, that the battering ram was firſt invented by the *Carthaginians*, while they laid ſiege to *Cadiz*. That was the ſimple kind above-mentioned. *Pephaſmenos* a *Tyrian*, contrived to ſuſpend it with ropes; and *Polydus* the *Theſſalian*, to mount it on wheels at the ſiege of *Byzantium*, under *Philip* of *Macedon*. Yet *Pliny* aſſures us the ram was invented at the ſiege of *Troy*; and that this gave occaſion to the fable of a wooden horſe.

Plutarch tells us, that *Mark Antony*, in the *Parthian* war, uſed a ram of 80 feet long; and *Vitruvius* aſſures us they were ſometimes made 106, and ſometimes 120 feet long, to which perhaps, the force of the engine was in a great meaſure owing.

The ram was managed at once by a whole century of ſoldiers, ſo that it played continually, and without intermiſſion; being uſually covered with a *vinea* to protect it from the attempts of the enemy.

The *vinea* was a kind of mantelet, or moveable parapet, built ſlighter, and yet larger than ours; being eight or nine feet high, as many broad, and ſixteen long: they were defended by a double covering, the one of boards, the other of faggots, with the ribs of oſiers, and caſed without with ſkins ſteeped in water, to prevent fire; for in proceſs of time, a certain compoſition of combuſtibles was invented, called *greek fire*, becauſe firſt uſed by the *Greeks*, to burn thoſe machines.

The compoſition was made of ſulphur, naphtha, pitch, gum, and bitumen; and was only extinguiſhable by vinegar, mixed with ſand and urine, or with raw hides.

The CATAPULTA was a machine us'd for throwing huge ſtones, and ſometimes large darts, and javelins 12 or 15 feet long, on the enemy.

The *Catapulta* is ſaid to be the invention of the *Syrians*. Some authors make it the ſame with the *Balliſta*: others different.

The BALLISTA is a round iron cylinder faſtened between two planks, from which reaches a hollow ſquare beam placed croſs ways, faſtened with cords, to which are added ſcrews; at one end of this ſtands the engineer, who puts a wooden ſhaft with a big head into the cavity of the beam; this done, two men bend the engine by drawing ſome wheels: when the top of the head is drawn to the utmoſt end of the cords, the ſhaft is driven out of the *Balliſta*, &c.

The SCORPION was alſo a military machine of the antients, uſed chiefly in the defence of walls, *&c.*

Marcellinus deſcribes the *Scorpion*, as conſiſting of two beams bound together by ropes: From the middle of the two roſe a third beam, ſo diſpoſed as to be pulled up and let down at pleaſure; and on the top of this were faſtened iron hooks, where was hung a ſling, either of iron or hemp. Under the third beam lay a piece of hair-cloth full of chaff tied with cords.

To uſe the engine, a round ſtone was put into the ſling, and four perſons on each ſide, looſening the beams bound by the ropes, drew back the erect beam to the hook; when the engineer ſtanding on an eminence, giving a ſtroke with a hammer, on the cord, to which the beam was faſtened with its hook, ſet it at liberty; ſo that hitting again the ſoft hair-cloth, it ſtruck out the ſtone with a great force.

It has its name *Scorpion*, becauſe when the long beam or tiller was erected, it has a ſharp top in manner of a ſting — more modern times have given it the name of *Onager*, wild aſs.

The TESTUDO, *Tortoiſe*, was a kind of cover, or ſkreen, which the ſoldiers, *e. gr.* a whole company made themſelves of their bucklers, by holding them up over their heads, and ſtanding cloſe to each other, this expedient ſerved to ſhelter them from darts, ſtones, *&c.* thrown upon them, eſpecially thoſe thrown from above, when they went to the aſſault.

Teſtudo was alſo a kind of large wooden tower which moved on ſeveral wheels, and was covered with bullocks hides ſtead, ſerving to ſhelter the ſoldiers when they approached the walls to mine them, or to batter them with rams. It was called *Teſtudo* from the ſtrength of its roof, which covered the workmen, as the ſhell does the Tortoiſe.

There were alſo moveable *towers of wood* mounted on wheels, to ſet the beſiegers on a level with the walls, and drive the beſieged from under the ſame. Theſe *towers* were ſometimes 30 fathom high; they were covered with raw ſkins, and 100 men employ'd to move them.

HAT-

HAT-MAKING.

HAT-MAKING is the art of preparing, mixing, and working together the hair of beaver, of hares, rabbits, or other animals, into a certain form to cover the head, both for uſe and ornament.

The antiquity of this manufacture goes no higher than about the year 1400. Before this time the head was covered with a *chapcroon* or ſort of a hood, ornamented and enriched, according to the degree or rank of the man that wore it.

Some date the uſe of caps at the ſame epocha: but, it is certain, from antient paintings, that the *pileus* or cap is of a much antienter invention and uſe. The cap made of velvet was called *mortier*, and was wore only by princes, kings and knights. The ſecular clergy and graduates in univerſities, wore peculiar caps by way of diſtinction.

They that make hats muſt be provided with a commodious ſhop, one part furniſhed for preparing the hair or wool; and the other for making the felts, and for dying and finiſhing the hats.

To make the *beaver hats*, they tear off the long and ſhort hair from the ſkin, with knives.

After which they proportion the quantity of the ſeveral ſorts of *beaver hair*, by mixing one third of the dry *caſtor* to two thirds of old coat: which is a term for a ſkin that has been worn ſome time by the Indians of *America*, who catch and ſell them to the *Europeans*.

The hair, ſo mixed, is carded and weighed out into parcels, according to the ſize and thickneſs of the hat intended. The ſtuff is laid upon the *hurdle*, with an inſtrument called a *bow*, reſembling that of a violin, but larger; whoſe ſtring being worked with a ſmall bow-ſtick, and made to play on the furs, they fly, and mix themſelves together, the duſt and filth at the ſame time paſſing through the chinks.

Thus hats are formed of an oval figure, ending with an acute angle at the top: with what ſtuff remains they ſtrengthen them where ſlendereſt, yet deſignedly make them thicker in the brim near the crown, than towards the circumference, or in the crown itſelf. They next harden the ſtuff, ſo managed, into more compact flakes, by preſſing down a hardened leather upon it.

This done, they are carried to the *baſon*, upon which laying one of the hardened hats they ſprinkle it over with water, and mould it; and the heat of the fire, with the water and preſſing, imbody the ſtuff into a ſlight hairy ſort of felt; after which, turning up the edges all round over the mould, they lay it by, and proceed with another, which being in like manner reduced to the ſame conſiſtence and form, they are both joined together, ſo as to make them meet in an angle at top, making only one conical cap.

The next proceſs is to remove the hat to a trough, reſembling a mill-hopper, which is a copper-kettle filled with water and grounds, kept hot for the purpoſe; and, after being dipped in the kettle, the hat is laid on the ſloping ſide, called the *plank*. Here they proceed to work it, by rolling and unrolling it again and again, one part after another, firſt with the hand, and afterwards with a ſmall wooden roller, taking care care to dip it from time to time, till at length, by thus fulling and thickening it four or five hours, it is brought to the dimenſions intended. In this violent labour, the workmen uſually guard their hands with thick leather, which they call gloves.

The hat thus wrought into the form of a conical cap, is reduced into proper ſhape on a block of the ſize of the intended crown, by tying it round with a ſtring, called a commander; after which, with a bent iron, called a *ſtamper*, they gradually beat down the commander all round, till it has reached the bottom of the block, and what remains at the bottom below the ſtring forms the brim.

In this ſtation it is ſet to dry, and afterwards ſinged, by holding it over the blaze of a fire, made of ſtraw, or ſhavings; it is then rubbed with *pumice ſtone*, to take off the coarſer nap; then rubbed over with ſeal-ſkin, to lay the nap ſtill finer; and laſtly, carded with a fine card, to raiſe the fine cotton, with which the hat is to appear when finiſhed: then fitting it to the block, they tie it, cut round the edges, and deliver it to the dyers.

The dye being completed, the hat is dried by being hung in the roof of a ſtove, heated with a charcoal-fire; and, when dry, it is ſtiffened with melted glue, or rather *gum-ſenega*, which is ſmeared over the hat with a bruſh, and rubbed in with the hand. Then, having ſpread a cloth over the ſteaming baſon, which is a little fire-place raiſed about three feet high, with an iron plate laid over it, exactly covering the fire, the hat is laid upon the cloth, with the brim downwards, the cloth being firſt ſprinkled with water, to raiſe a ſtrong ſteam, to force in the ſtiffening. When it is moderately hot, the workman ſtrikes gently on the brim, with the flat of his hand, to make the joinings incorporate, and bind ſo as not to appear, turning it from time to time, and at laſt ſetting it on the crown. And when it has been ſufficiently ſteamed and dried, it is put again on the block, bruſhed, ironed, well ſmoothed, and fitted for lining.

Hats are alſo made for women's wear, of chips, ſtraw,

straw, or cane, by platting, and sewing the plats together; beginning with the center of the crown, and working round till the whole is finished. Hats for the same purpose are also wove and made of horse-hair, silk, &c.

HERALDRY.

HERALDRY, is the art of armory and blazoning; or, the knowledge of what relates to the bearing of arms, and the laws and regulations thereof.

Arms, or *Armories*, are marks of dignity and honour, regularly composed of certain figures and colours, given or authorized by sovereigns, and bore in banners, shields, coats, &c. for the distinction of persons, families, and states, and passing by descent to posterity.

They are called *arms*, in regard they are bore principally on the buckler, cuirasse, banners, and other apparatus of war; and by the *English coats of arms*, *coat armour*, &c. because antiently embroider'd on a cloak or habit, worn by the antient knights over their arms, both in war and at tournaments; and still borne by the heralds at arms.

It was a kind of surcoat, reaching only as low as the navel, open at the sides, with short sleeves; sometimes furred with *ermine* and *vair*, wherein were applied the *armories* of the knight, embroidered with gold and silver, and enamelled with beaten tin, colour'd *black*, *green*, *red*, and *blue*; whence the rule never to apply colour on colour, nor metal on metal.

The *coats of arms* were frequently open, and diversified with bands and fillets of several colours, alternately placed, as we still see cloths scarleted, watered, &c. Hence they were also called *devices*, or *devises*, and being divided, or composed of several pieces sewed together, whence the words *fesse*, *pale*, *chevron*, *bend*, *cross*, *salter*, *lozenge*, &c. which have since become honourable pieces, or ordinaries of the shield.

The surcoat being embroider'd with *gold* and *silver*, was the occasion that those two metals have been since placed in the coats of arms, under their *French* name of *or* and *argent*; and there being colour'd *black*, *green*, *red*, and *blue*; that those different colours have also been introduced in them: therefore,

There are two metals in *Heraldry*, viz. *or* and *argent*; and seven colours, which are, *gules*, *azure*, *sable*, *vert*, *purpure*, *tenne*, and *sanguine*.

OR, in the coats of arms is painted yellow, and represented in engraving by small points or *dots*, all over the field, or bearing,

In the coats of nobles it is called *topaz*; and in those of sovereign princes *sol*; by the *English* Heralds.

Without this, or *argent*, there can be no good armory; and it is accounted the symbol of wisdom, temperance, faith, force, constancy, &c.

ARGENT, from the *Latin argentum*, silver; is painted *white* in the escutcheons, and expressed in engraving, by the parts being left *plain*, without any strokes from the graver.

The *English* observe the same distinction in this, as in *or*, and call for barons and all nobles, the white colour *pearl*; and for sovereign princes, *luna*.

In the doubling of mantles, where the white is supposed to represent a fur, and not a metal, it may be blazon'd white.

GULES, is painted *red*; and in engraving expressed by *perpendicular strokes*, drawn from the top of the escutcheon to the bottom.

Gules is reputed a symbol of charity, valour, hardiness, generosity, and represents blood colour, cinnabar, and true scarlet. Antiently it was prohibited any person to wear *gules* in his coat armour, unless he was a prince, or had permission from the prince.

AZURE, is painted *blue*; and in engraving is represented by strokes or hatches drawn *horizontally*.

SABLE, is painted *black*; and expressed in engraving by *perpendicular* and *horizontal* hatches drawn a-cross each other.

VERT, is painted *green*; and in engraving is expressed by *diagonals*, or lines drawn athwart from right to left, from the dexter chief corner to the sinister base.

PURPURE, or PURPLE, is a compound of *gules* and *azure*; bordering on violet, it is painted in its natural colour, and represented in engraving by *diagonal lines* drawn from the sinister chief to the dexter base point, as in the *Plate*.

Spelman allows *purple* the preference before all other colours, as having been an ensign of royalty for many ages; yet he allows it to have been excluded by the antient Heralds as only an imperfect colour.

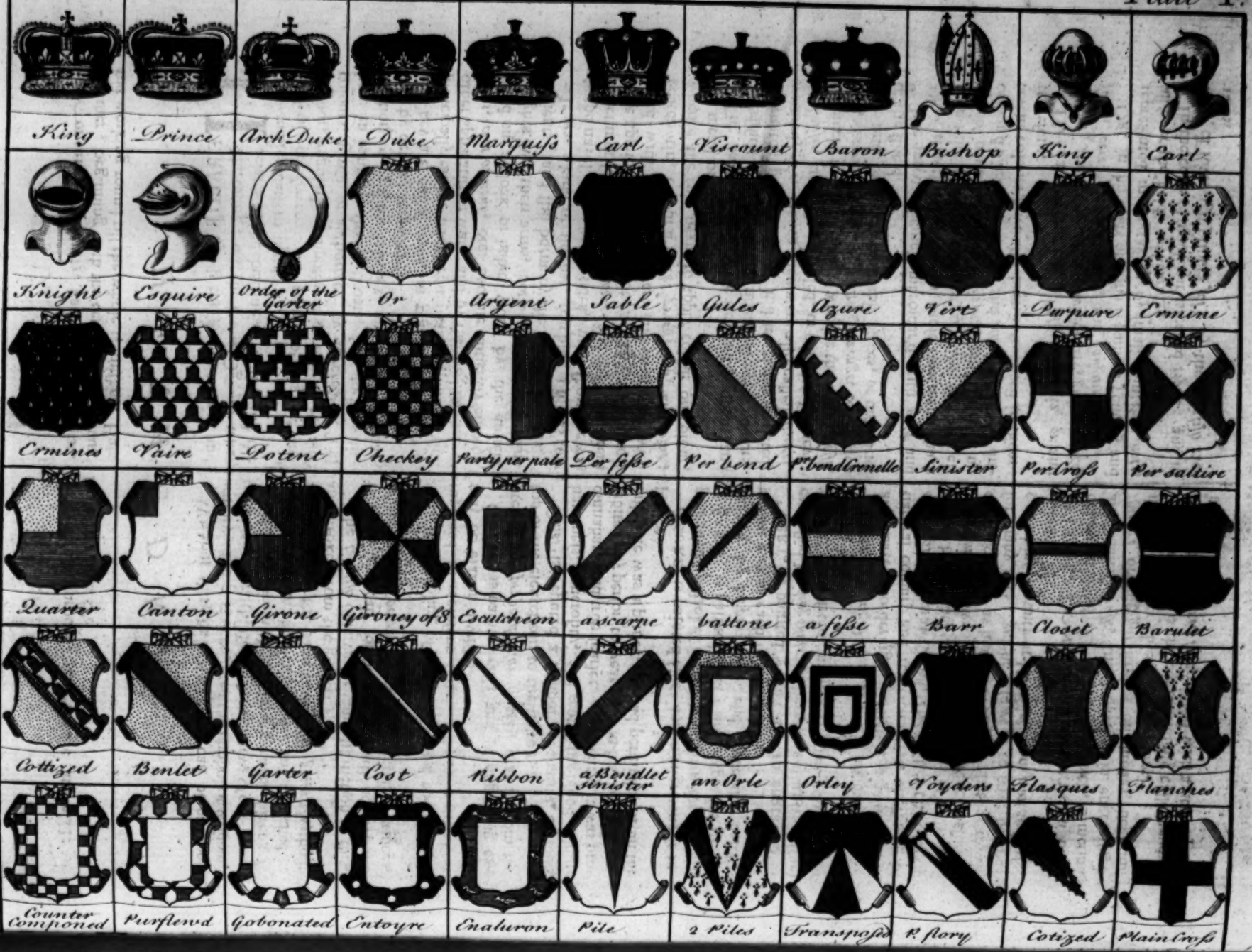
TENNE, TENNY, or TAWNY, is a bright colour made of *red* and *yellow* mixed, sometimes also called *brusk*, and expressed in engraving by *thwart* or *diagonal* strokes or hatches, beginning from the sinister chief, like purpure.

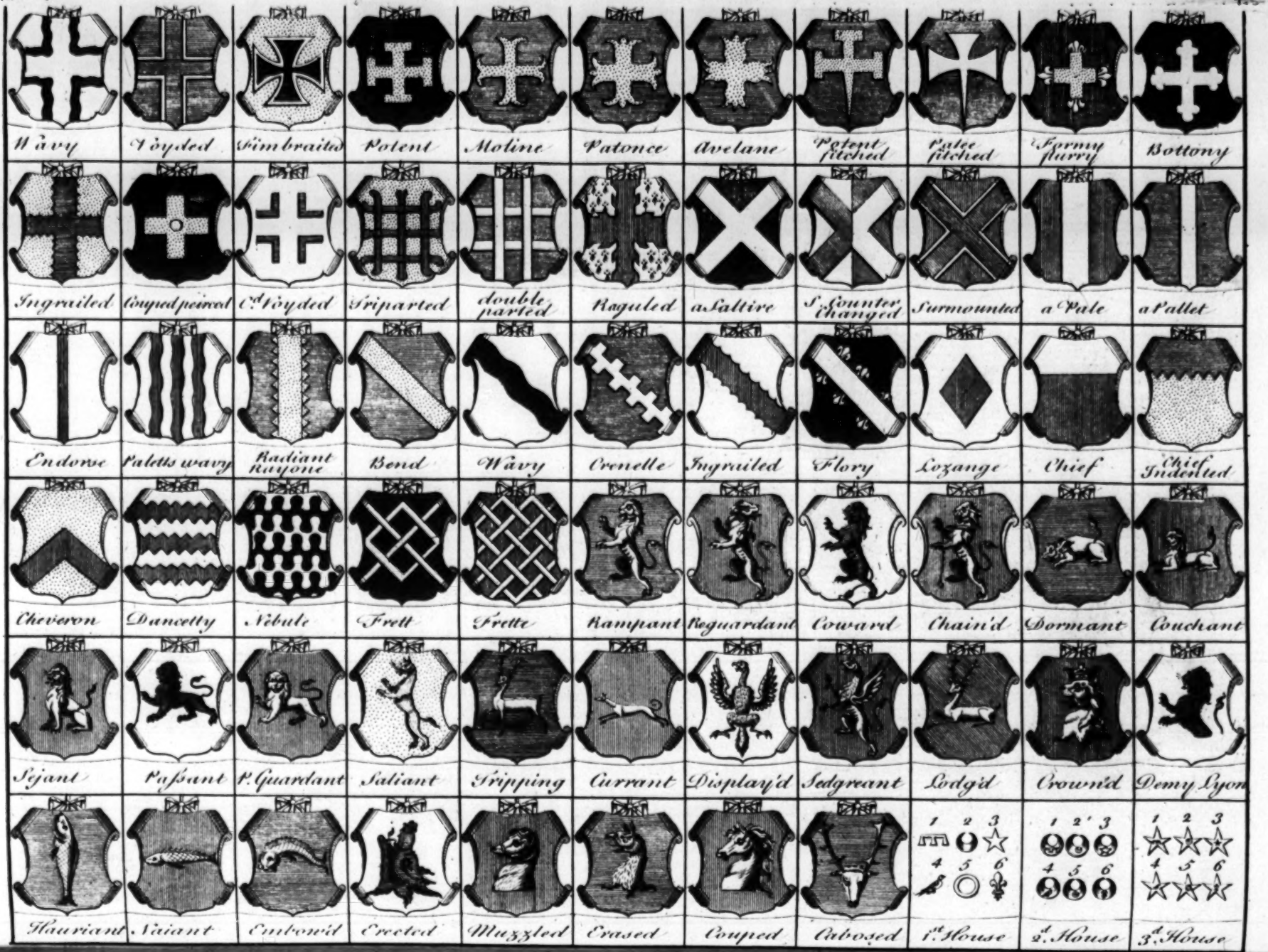
SANGUINE is the colour usually called *murrey*, being made of *red lake*, tinged with a little *Spanish* brown.

It

HERALDRY.

Plate I.




Wavy
Voyded
Fimbraited
Potent
Moline
Patonce
Avelane
Potent fitched
Pate fitched
Formy flurry
Bottony
Ingrailed
Cuped peirced
Cr. Voyded
Triparted
double parted
Raguled
a Saltire
S. Counter changed
Surmounted
a Pale
a Pallet
Endorse
Paletts wavy
Radiant Rayone
Bend
Wavy
Crenelle
Ingrailed
Flory
Lozange
Chief
Chief Indented
Cheveron
Dancetty
Nebule
Frett
Frette
Rampant
Reguardant
Coward
Chain'd
Dormant
Couchant
Sejant
Passant
P. Guardant
Saliant
Tripping
Currant
Display'd
Sedgreant
Lodg'd
Crown'd
Demy Lyon
Hauriant
Naiant
Embowid
Erected
Muzzled
Erased
Couped
Arbosed
1. House
2. House
3. House

THE SEAL OF THE PREROGATIVE COURT OF THE ARCHBISHOP OF CANTERBURY.

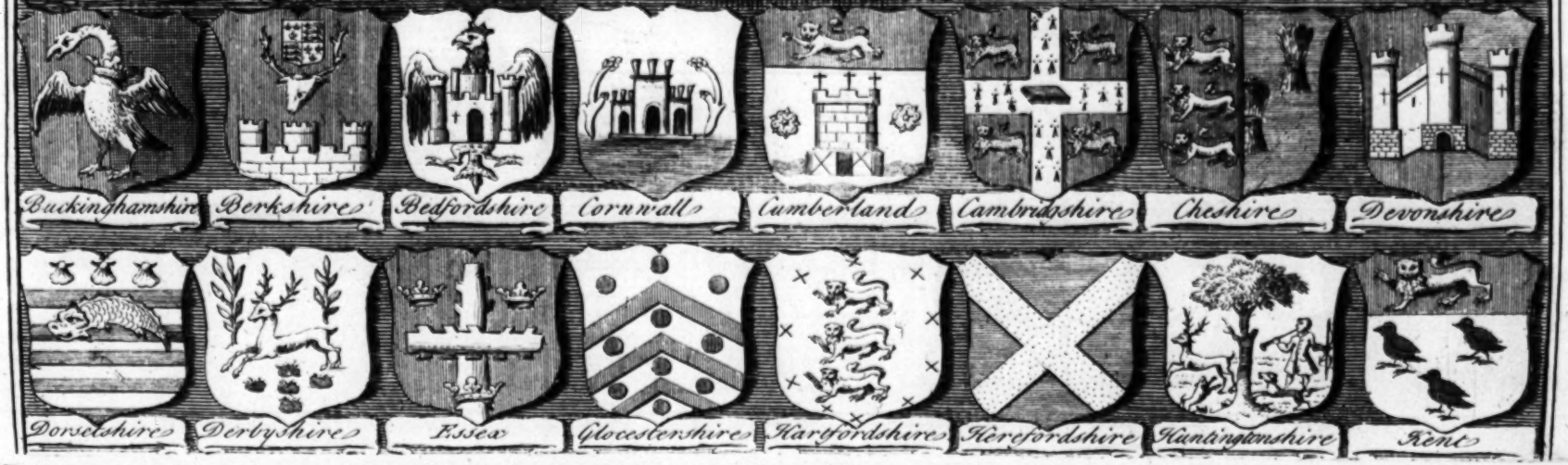
THE GREAT SEAL OF ENGLAND.

GEORGIUS · II · DEI · GRATIA · MAG · BRITANNIÆ · FRANCIÆ · ET · HIBERNIÆ · REX · FIDEI · DEFENSOR

THE SEAL OF THE LORD MAYORS COURT.

DOMINE DIRIGE NOS

The SEALS of the Several Counties in ENGLAND and WALES.



SEALS. *Plate 2.*

B. Cole sculp.

BRITISH MUSEUM
OCT 30 47

It is repreſented in engraving by tranſverſe hatches like purpure, and is moſtly uſed in the coats of knights of the bath.

An *eſcutcheon* * is a ſhield or coat, wherein the bearing or arms of any perſon is repreſented, and is of a ſquare figure, excepting the bottom part, which is uſually a little rounded, ending in a point in the middle.

Till within a few hundred years the *eſcutcheons* of the *French* and *Engliſh* were triangular: thoſe of the *Spaniards* are ſtill quite round at bottom without any point: thoſe of the *Italians* are oval; and thoſe of the *Germans* in form of cartoozes.

The antient *eſcutcheons* were generally couched or inclin'd; and they only began to place them upright, when crowns, *&c.* were put over them by way of creſt.

The ſeveral parts or points of the *eſcutcheon* have their ſeveral names, *viz.* the *dexter chief point*; the *middle chief*; and the *ſiniſter chief point*; the *honour point*; the *feſſe point*; the *nombril point*; the *dexter baſe*; the *middle*, and the *ſiniſter baſe* point.

The *eſcutcheon* is diverſly denominated, according to its diviſions. It is called *dextered*, when the perpendicular line that divides it, is to the right of a third part of the *eſcutcheon*; *ſiniſtered*, when on the left; *tierced in pale*, when this line is double, and divides the *eſcutcheon* into three equal parts; *paled*, when increaſed to the number of ſix, eight, or ten. A horizontal line makes the chief, when at a third part from the top; the *plein*, when at a third part from the bottom; and when double, in the middle, at an equal diſtance from both extremes, it makes the *feſs*, and the *tierced in feſs*; when it is multiplied, it denominates it *feſſed*; when there are 8 or 10 equal ſpaces, *burelle*; a diagonal from the dexter point of the chief, to the ſiniſter of the baſe, makes it *tranché*; the contrary, *double*. If it be double at equal diſtances, the firſt makes *bandé*, and the *tierce in bende*, and the other *barré*, or *tierce in bar*; increaſing the number of the firſt makes *bandé* and *cottiçé*; and increaſing that of the ſecond, *barré* and *traverſé*.

There is alſo *eſcutcheon of pretence*, which is an *ineſcutcheon*, or little *eſcutcheon*, which a man who has married an heireſs, and has iſſue by her, may bear over his own coat of arms; and in it the arms of his wife; and the ſurviving iſſue will bear both coats quarterly.

The ſurface, or face of the *eſcutcheon*, is called the FIELD, becauſe it contains the atchievements antiently acquir'd in the field of battle, *e. gr.* the field in the coat of arms of *England*, is *gules*; in that of *France*, *azure*, &c. which field is always named in blazoning, before any other part of the *eſcutcheon*.

The field being laid, we'll charge it with ſome pieces, obſerving that all common charges, or bearings are born *in*, *upon*, *within*, or *between*, *chief*, *pales ſaltier*, *chevron*, *croſs*, *canton*, *feſs*, *gyron*, *pile*, *eſcutcheon*, *bordure*, or *orle*.

Counter-charges of colour or metal, is when a field is divided by a ſingle line, and the charge exchanges colour as it goes over both.

There are different lines in the *eſcutcheon*, as *right*, *crooked*, *engrailed*, *invecked*, *waived*, *crenelled*, or *embattled*, *nebuled*, or *cloudy*, *indented*, and *dancette*.

A *right line* is carried equally throughout the *eſcutcheon*, without riſing or falling.

A *crooked line* is either *bunched* or *corner'd*, which crooked line is the origin of all the following ones, *viz.*

ENGRAILED, or INGRAILED, (from the *French greſle*, hail) is when a thing is repreſented with its edges ragged, or notched circularly, as if broke by ſomething falling on it.

INVECTED denotes a thing flatted or furrowed and is the juſt reverſe of engrailed, becauſe the points of *invected* are turn'd inward to the ordinary.

WAVED, is when a bordure, or any ordinary charge, has its outer lines indented, in manner of the riſing or falling of waves. This is alſo called *undy*, *undé*, or *ondé*.

CRENELLED, or EMBATTLED, is when any honourable ordinary is dented, after the manner of battlements of a wall.

NEBULED is when a coat is charged with ſeveral little figures in form of clouds, running within one another, or, when the outline of a bordure, ordinary, *&c.* is indented or waved.

INDENTED, INDENTEE is when the outline of a bordure, ordinary, *&c.* is notched in form of the teeth of a ſaw.

DANCETTE is when the outline of any bordure, or ordinary, is indented very largely; the largeneſs of the indentures being the only thing that diſtinguiſhes it from the indented.

There is alſo a bearing of a bend, called double *dancetté*; thus he beareth azure, a bend double *dancetté* argent.

Of theſe different lines are compoſed all bordures, and honourable ordinaries, an *eſcutcheon* is charged with.

* From the *Latin ſcutum*, ſhield; which was the place, arms were originally bore on, before ever they came in banners; and ſtill wherever they are placed, it is on ſomething repreſenting the form of a ſhield. The *Latin ſcutum*, no doubt, came originally from the *Greek* Σκυτος *leather*, wherewith the ſhields were uſually covered.

A Bordure is a kind of addition on the limb of an *escutcheon*, in form of a hem, or girdle, encompassing it all round. The *bordure* must be about one sixth part of the breadth of the shield.

Simple bordure, is that which is of the same colour or metal throughout; and is the first addition of younger brothers.

There are others *componed*, *countered*, *ingrailed*, *indented*, and *charged* with other pieces; which make different additions for younger brothers, in several degrees.

If the line which constitutes the *bordure* be strait, and the *bordure* plain, the colour of the *bordure* alone is named: as *he beareth gules, a bordure or.* If a bordure be charged with any parts of plants or flowers; they say, *verdoy of trefoils.* If it consist of ermines *vairy*, or any of the furs, the term is *perflew of ermines.* If the *bordure* be charged with martlets, the word is, *charged with an enaluron of martlets*, &c.

The Honourable, or *honourable ordinaries*, are the principal *ordinaries* or bearings, which, when in their full extent, may possess one third of the field.

These are ten in number, *viz.* the *cross*, *chief*, *pale*, *bend*, *fesse*, *bar*, *saltier*, *chevron*, *bordure* and *orle.*

The Cross, is defined by *Guillim*, an ordinary composed of four-fold lines; whereof two are perpendicular, and the other two transverse; for so we must conceive of them, though they be not drawn throughout, but meet by couples, in four right angles, near the fess-point in the *escutcheon.*

The content of a *cross* is not always the same: for when it is not charged, canton'd, nor accompanied, it has only the fifth part of the field; but if it be charged it must contain the third part thereof.

This bearing was first bestow'd on such as had perform'd, or at least undertaken, some service for *Christ*, and the *christian* profession; and is held by divers the most honourable charge in *Heraldry.* What brought it into such frequent use, was the antient expeditions into the *Holy Land*; and the holy war pilgrims, after their pilgrimage, taking the *cross* for their cognizance, and the ensign of that war being the *cross*; whence its name *croisade.*

St. *George's cross*, or the *red cross*, in a field argent, is now the standard of *England.*

Guillim enumerates thirty-nine different sorts of *crosses*, *viz.*

A *cross voided*, which differs from the *cross frimbriated*, in that this latter does not shew the field through it, as the other does. And the same obtains in other ordinaries.

A *cross wavy voided*, which is a *cross* whose outlines are indented, in manner of the rising and falling of waves.

A *cross patee* is a *cross* small in the center, and widening towards the extremes.

A *cross patee fitched* on the foot, is a *cross* whose foot is made sharp, that it may be more apt to be fastened any where.

A *cross patee* on three parts, and *fitched* on the fourth, which is a *cross* whose whole fourth part is *figetive.*

A *crose engrailed*, which is a *cross* whose edges are ragged, or notched circularly.

A *cross patonee*, which is a *cross* formed of bunched lines; extending and stretching to a certain *patee* form. *Colomb* calls it *croix enhencee*, and not *patonee.*

Cross fleury, which is a *cross*, that turns down its extremities like a *Fleur de lys.*

A *cross velane*, which is a *cross* whose quarters resemble the filberd nuts.

A *cross crosselet*, which is a *cross* terminating in *crosselets*, or little *crosses.*

A *cross botone*, which is the *cross* the *French* heralds call *trefflee*, from *treffle*, a trefoil, or three-leaved grass, which the ends of this *cross* imitate.

A *cross pomel*, which is a *cross* whose extremities are in the form of round balls, like the end of the guard and grasp of a sword, whence it borrows the name *pomel.*

A *cross urde*, which seems to be the same with what we call *clechée.*

A *cross degraded fichée*, which is a *cross* with degrees or sort of steps at each extream.

A *cross potent*, which is a *cross* with its extreams in the form of a *crutch.*

A *cross cavalry*, which is a *cross* long in the pale, and short in the arms, resembling the *cross* of our redemption fixed on Mount *Calvary.*

Patriarchal cross, which is that, where the shaft is twice crossed, the lower arms or traverse being longer, and the upper shorter; it is also called a *cross of Lorrain.*

An *anchored cross*, which is a *cross*, whose points are made sharp, like those of an anchor.

A *cross moline*, which turns round both ways at all its extremities, though not so wide or sharp as that said to be anchored.

Cross clechee, which is a *cross* open to the light, or pierc'd through with another inner one of the same figure, *e. gr.* when a *cross* appears as if charged with another *cross* of the same colour with the field, or as if the field appear'd through the apertures thereof.

Cross flory, or *fleur de lisee*, which is a *cross*, the extremities whereof are in the form of flowers, lilies, flower de luces.

A *cross double fiche*, or *double fichy*, which is a *cross* whose extremities are pointed at each angle; that is,

is, each extremity has two points: In contradiſtinction to *fiche*, where the extremity is ſharpened away to one point.

Croſs à ſeize pointes, which is a *croſs*, each extremity whereof has four points.

Croſs milrine, which is a *croſs*, the extremities whereof are hooked.

A *raguled croſs*, which is a *croſs* whoſe outlines are jagged or knotted.

A *croſs pall*, which is a *croſs* repreſenting the *pallium*, or archiepiſcopal ornament ſent from *Rome* to metropolitans.

A *tau*, or *croſs of St. Anthony*, which is a *croſs* in the form of a T.

A *croſs pierced*, which is a *croſs* perforated, or ſtruck through, ſhewing as it were a hole in it.

This *piercing* is to be expreſſed in blazon, as to its ſhape: Thus if a *croſs* has a ſquare hole or perforation in the center, it is blazon'd *ſquare pierced*. When the hole or perforation is round, it muſt be expreſſed *round pierced*, which *Gibbon*, in *Latin* calls *perforata*, becauſe all holes made with piercers or augers are round. If the hole in the center be in the ſhape of a lozenge, it is expreſſed *pierced lozenge ways*.

All piercings muſt be of the colour of the field, becauſe piercing implies the ſhewing of what is under the ordinary or bearing. Though when ſuch figures appear on the center of a *croſs*, &c of another colour, the *croſs* is not to be ſuppoſed pierced, but that the figure on it is a charge, and muſt be accordingly blazoned.

The *Saltier* is a kind of St. *Andrew*'s *croſs*, and was antiently called the *croſs of Burgundy*.—The *Saltier* may be ſaid to be compoſed of a bended dexter and ſiniſter, croſſing each other in the center of the eſcutcheon. Its ordinary breadth when alone is one third of the eſcutcheon. It is ſometimes bore alaizé, and ſometimes in number, placed in different parts of the field: Sometimes charged, countercharged with the field, accompanied, raguled, engrailed, indented, quarterly-quartered, *&c.*

Colombiere adds thirty-three more ſorts of *croſſes* to thoſe above-mentioned, *viz.*—A *croix remplie*, which is only one *croſs* charged with another; a *croſs party*, that is, one half of one *colour*, and the other of another; a *croſs quartered*, that is, the oppoſite quarters of ſeveral colours; a *croſs of five pieces*, that is, of ſo many colours; a *croſs mouſſue* and *abaiſſée*; a *croſs barbée*; a *croſs croiſſantée*, or *creſcented*, that is, having a creſcent at each end; a *croſs forked* of three points; a *croſs panitée* of three pieces; a *croſs reſſercelée*; a *croſs pointed*; a *croſs ankered*, and *fur ankered*; a *croſs ankered* with ſnakes heads; a *croſs orled*; a *high croſs*; a *croſs rayonnante*, or caſting out rays of glory; a *croſs of Malta*; a *croſs of the holy Ghoſt*; a *croſs forked* like the antient reſts for muſkets; a *croſs with eight points*; a *croſs bourdonnée*; a *croſs cramponée* and *tournée*; a *croſs cablée*; a *croſs inclining*; a *croſs pater noſtree*, that is made of beads, though we moſt properly call it *une croix en chapellet*; a *croſs treflée*; a *croſs fleuronée*; a *croſs vaidée*, *clechée*, and *pommetée*; a *croſs crenellée* and *battilée*; a *croſs* with four ſteps to every arm; a *croſs rounded*; a *croſs and an half*; a *croſs eſtoillée* or ſtarways; a *croſs corded*; a *croſs doubled* of ſix pieces ſet together; a *double croſs* ſolit in pale, a *long croſs* cut in pieces and diſmembered; a *croſs couped*, or cut through in feſſe, of the two contrary colours to the field; a chevron ſurmounted by an *half croſs*; four tails of ermines in a *croſs*, the tops of the ermines oppoſite to each other in the middle; four pieces of wire placed croſs-ways, and counterpointing in the center; the *croſs* or *ſword of St. James*; *croſs potence cramponée* on the dexter upper arm, and a potence about the middle of the ſhaft.

Theſe are the various *croſſes* we find in authors, which ſome may think too many, as not being all uſed in *England*; but *Heraldry*, like all other arts and ſciences, extends to all countries, and all terms uſed require to be explained.

The *Chief* is the ſecond honourable ordinary, and is placed athwart the top of the coat, containing one third part of its height.

When the eſcutcheon is cut in ſtone, or in relievo, the *chief* ſtands prominent beyond the reſt, and is ſuppoſed to repreſent the diadem of the antient kings and prelates, or the caſks of the knights.

It is frequently without any ornament; ſometimes it is charged with other bearings; ſometimes it is of a colour or metal different from that of the coat.

The line that binds it at bottom is ſometimes ſtrait, ſometimes indented, engrailed, embatteled, lozenged, *&c.* Thus, ſay they, the field is gules, a chief argent, *&c.* Again he bears gules, a chief crenele, or embatteled argent.

Sometimes one *chief* is borne on another, expreſſed by a line drawn along the upper part of the *chief*; when the line is along the under part it is called a *fillet*. The firſt is an addition of honour, the ſecond a diminution.

The *chief* is ſaid to be *abaiſed*, when it is detached from the upper edge of the coat, by the colour of the field which is over it; and which retrenches from it one third of its height.—They alſo ſay, a *chief* is *chevroned*, *paled*, or *bended*, when it has a chevron, pale, or bend contiguous to it, and of the ſame colour with itſelf.—A chief is ſaid

to

to be ſupported, when the two thirds a-top are of the colour of the field, and that at bottom of a different colour.

Pale, the third honourable honorary, is the repreſentation of a pale or ſtake placed upright; and comprehending the whole height of the coat, from the top of the chief to the point.—When the *pale* is ſingle, it is to contain one third of the breadth of the ſhield; when there are ſeveral more properly called *pallets*, they are proportioned ſo, as that two take up two fifths of the ſhield, and three take up three ſevenths: and in thoſe caſes the number of pieces is ſpecified as well as that of thoſe they are charged withal, *&c.*

Pales are bore various ways, as *wavy*, *crenelle*, *faillis*, *inaentea*, *ingrailea*, &c. There are alſo *cometed*, and *flaming pales*, which are pointed, ſometimes waved, *&c.*

A Pallet, in the *Engliſh* Heraldry, is the moiety or one half of the *pale*, and therefore receives its name of diminution, as being a demy or little pale: and an endorſe is the fourth part of the *pallet*.

The Bend, our next honourable ordinary, is formed by two lines, drawn diagonally or athwart, from the upper part of the ſhield on the right, to the lower part on the left; being ſuppoſed to repreſent a ſhoulder belt, or ſcarf worn over the ſhoulder.—It contains a third part of the field when charged, and a fifth when plain. It is ſometimes indented, ingrailed, *&c.*

Heralds ſpeak of a *bend dexter*, and a *bend ſiniſter*.—A *bend dexter* is that properly and abſolutely called a *bend*; which word *dexter* is uſually annexed to prevent miſtakes, and diſtinguiſh it from the *bend ſiniſter*, which is the ſame with what is otherwiſe called after the *French* heralds, a *bar*, *barre*.

The *bend ſiniſter* is ſubdivided into the *ſcarf* or *ſcarp*, and the *battoon*; which latter is the fourth part of the *bend*, and the moſt uſual mark of illegitimacy; but then it never extends itſelf quite athwart the ſhield, but is cut off a little at each end.

When two ſtrait lines drawn within the *bend*, run nearly parallel to the outward edges of it, this is called *voiding*; and he that bears it, is ſaid to bear a *bend* voided.

A *bend* is ſubdivided into a *benlet* or *bandelet*, which is the ſixth part of the ſhield; a *garter*, which is the moiety of a *bend*; a *coſt*, which is the fourth part of a *bend*; and a *ribband*, which is the moiety of a *coſt* or *cotiſe*.

Fesse, the next honourable ordinary of the eſcutcheon, divides it horizontally in the middle, and ſeparates the chief from the point. It is ſuppoſed to repreſent a broad girdle, or belt of honour, which knights at arms were antiently girded withal. The *feſſe* poſſeſſes the center of the eſcutcheon, and contains in breadth one third part thereof. When it takes up leſs than its proper breadth it is called a *bar*.

Chevron, or Cheveron, the next ordinary, repreſents two rafters of a houſe joined together, without any diviſion. It deſcends from the chief towards the extremities of the coat, in form of a pair of compaſſes half open.

When it is alone it ſhould take up the third part of the coat: when it is accompanied with any other bearings, its breadth muſt be adjuſted thereby.

It is bore divers ways, ſometimes in chief, ſometimes in baſe, ſometimes marched, ſometimes reverſed, *&c.*

The *chevron* is ſometimes charged with another *chevron*, one third of its own height.

Two *chevrons* are allowed in the ſame field, but not more; when they exceed that number they are called *chevronwiſe* or *chevronels*. There are *chevrons* of ſeveral pieces.

A *chevron* is ſaid to be abaſed, when its point does not approach the head of the chief, nor reach further than the middle of the coat; *mutilated* when it does not touch the extremes of the coat; *cloven*, when the upper point is taken off, ſo that the pieces only touch at one of the angles; *broken*, when one branch is ſeparated into two pieces; *couched*, when the point is turned towards one ſide of the eſcutcheon; *divided*, when the branches are of ſeveral metals, or when metal is oppoſed to colour; *inverted*, when the point is towards the point of the coat, and its branches towards the chief.

A coat is ſaid to be *chevroned*, when it is filled with an equal number of *chevrons*, of colour and metal.

Counter-chevroned, is when it is ſo divided, as that colour is oppoſite to metal, and *vice verſâ*.

The next in order to the chevron is the *bar*, *barr*, or *barre*, nearly reſembling the *feſſe*; from which it only differs by its narrowneſs, and by this, that the *bar* may be placed in any part of the field, whereas the feſs is confined to a ſingle place.

Giron is an ordinary conſiſting of two ſtrait lines drawn from divers parts of the eſcutcheon, and meeting in an acute angle in the feſs point of the ſame.

The word is *French*, and literally ſignifies the *gremium* or lap. In *Latin* they are called *pinnulæ octonæ*, and *merli octango-laxi* by the *Italians*.

If the *Girons* be eight in number, ſays *Mackenzy*, they need not be expreſſed, but if there be fewer, or more, it muſt.

Girons are bore diverſely, *viz.* ſingle, by couples of ſix, of eight, of ten, and of twelve.

When

When a coat has ſix, eight, or ten of theſe *Girons*, meeting or centering in the middle of the coat, it is ſaid to be *gironné* or *girrony*.

Some, inſtead of *gironné*, ſay *parti*, *couppé*, *tranché*, and *taillé*, by reaſon the *Girons* are formed by ſuch diviſions of the field. Four *Girons* form a ſaltier, and eight a croſs.

The heralds give ſeveral reaſons for the heretofore mention'd ordinaries, being called *honourable*. 1. Their great antiquity, as having been uſed ever ſince armory was ſet on foot. And, 2. For that they denote the ornaments moſt neceſſary for noble and generous men: thus the *chief* repreſents the helmet, wreath, or crown, covering the head: the *pale* repreſents his lance or ſpear: the *bend* and *bar*, his belt: the *feſſe*, his ſcarf: the *croſs* and *ſaltier*, his ſword: the *chevron*, his boots and ſpurs: and the *bordure* and *orle*, his coat of mail.

As to the allotting or diſtributing of theſe *ordinaries*, ſome authors write, that when a gentleman having behaved himſelf gallantly in fight, was preſented to the prince, or general, and a ſuitable coat armour order'd him; if he were wounded in the head, they gave him a chief; if in the legs he had a chevron; and if his ſword and armour were diſcolour'd with the blood of enemies, a croſs or bordure.

Beſides the above mention'd *honourable ordinaries*, there are other ordinaries, compoſed of the like lines, *viz.*

The CANTON, which is a ſquare portion of the eſcutcheon, parted from the reſt. It has not any fixed proportion; tho' regularly it ſhould be leſs than a quarter: it is often only a ninth part, and uſed as an addition or difference, frequently to expreſs baſtardy.

The *canton* is ſometimes placed at the right corner, and ſometimes at the left, in which latter caſe, it is called a *canton* ſiniſter.

The *canton* is form'd of two ſtrait lines, the one drawn perpendicularly from the chief, and the other tranſverſe from the ſide of the eſcutcheon, and meeting therewith in a right angle, near to the corner of the eſcutcheon.

The QUARTER, an ordinary of the like compoſition with the canton, and occupies the ſame places, and bears a great reſemblance to it; inſomuch that the ſame rules that ſerve for the one, may be attributed to the other. The ſole difference between them is, that the canton keeps only a cantle or ſmall portion of the eſcutcheon; and the *quarter* comprehends the full fourth part of the eſcutcheon.

The PILE, which is an ordinary conſiſting of two-fold lines, formed in the manner of a wedge, that is to ſay, broad at the upper end, and diminiſhing by degrees throughout with a comely narrowneſs, and taper growth, meeting together at the lower end in an acute angle.

The *pile* is borne inverted, ingrailed, *&c.* like other ordinaries, and iſſues indifferently from any point of the verge of the eſcutcheon. He bears a *pile* gules by the name of *Chandois*.

The FLASK, or FLANCH, which is an ordinary formed by an arched line, which begins at the corner of the chief, and ends in the baſe of the eſcutcheon. *Flanches* are always borne by pairs.

The VOIDER, an ordinary, whoſe figure is much like that of the *Flaſk* or *Flanch*; only that it does not bend ſo much.

This armory, they ſay, is properly the reward of a gentlewoman that has well ſerved her prince. It is always borne by pairs.

Beſides the above-mention'd charges of the eſcutcheon, which are called *proper*, there are others called *common charges*, viz. *celeſtial intelligences*, as *Angels*, *Cherubims*, &c. Planets, as the *Sun*, *Moon*, *Stars*, &c. Foſſils, as all ſorts of precious and other ſtones; Vegetables, as *Fruits*, *Trees*, *Flowers*, &c. Animals, as *Lions*, *Leopards*, *Wolves*, *Horſes*, *Griffins*, *Bears*, *Eagles*, *Cocks*, &c. *Piſhes* of all ſorts.

Angels and *cherubims*, are either *volent*, *ſtanding*, or *kneeling*, with their wings either *extended*, *diſplayed*, or *croſſed*; and theſe are often of different metals or colours. The *angels* almoſt always at full length; and the *cherubims* with only their head and wings.

Of the *heavenly bodies*, the *Star* is the firſt in dignity.

The *Star* in *Heraldry*, uſually conſiſts of five rays or ſparks. When it has ſix or eight, as among the *Germans* and *Italians*, particular mention muſt be made thereof in blazoning.

The *Sun* is blazoned according to his different phaſes, and is either called *in its glory*, or *rayoning*, when in its greateſt radiancy; or eclipſed, or in a cloud, and ſometimes none but his rays appearing.

The *Moon* is alſo blazon'd according to its phaſes; and is either *creſcent*, when with her horns up to the chief of the eſcutcheon; or *increſcent*, when ſhe enters into her firſt quarter, and has her horns towards the dexter part of the eſcutcheon; and when in her eclipſe, it is called *detriment*.

A *Comet* has alſo its place in *Heraldry*, and is called *ſtreaming*.

The *elements*, ſometimes found in an eſcutcheons, are,

The

The *Fire*, which is conſider'd as the moſt noble of them, and is either *flamant* or *ſcintillant*, and ſometimes both.

The *Sea*, which we'll take for water in general, is blazon'd waved in *French ondoiee*.

The *Earth*, is ſeldom or never repreſented but in part, in the blazon, which admits only of mountains, rocks, and iſlands, which are differenced by their metal or colour.

Of all precious ſtones, the *eſcarbuncle* is the moſt in uſe in *Heraldry*; and is a charge or bearing conſiſting of eight radii, or ſpokes; four whereof make a common croſs and the four a *ſaltier*.

Some call theſe radii *battons*, or *ſtaves*, becauſe round and enriched with buttons, or pearl'd like pilgrims ſtaves; and frequently tipped or terminated with flower de luces. Others blazon them royal ſcepters, placed in ſaltier pale and feſſe.

We'll paſs from theſe to the *vegetables*, and among them place *trees* firſt in order; which are blazoned in a different manner, according to their different products, ſhapes, *&c.* for example, according to their products, an oak is blazoned *acorned*, a pine apple-tree, pear-tree, *&c. fructed*; if repreſented with fruits on them.

According to their ſhapes, they are either trunks of trees, and are blazon'd *eradicated*, or *mooted up by the root*; or limbs of trees, and are blazon'd *trunkated* or *raguled*, or both; or ſtocks or ſtumps of trees, and are blazon'd *couped*, or *eradicated* or both; or branches of trees, which are blazon'd either *ſtarved* or *ſlipped*, or both: or ſlips or leaves, which are blazon'd either *pendant*, *bendways*, *barways*, *ſlipped*, *proper*, *in ſaltier*, or *erected*.

The fruits of trees have alſo their place in *Heraldry*, and are either *ſlipped*, *pendant*, *erected*, *proper*, or have their ſtalks trunkated.

Trees, their trunks, limbs, branches, ſlips, fruits, *&c.* are all of the different metals and colours adapted to *Heraldry*.

Flowers are the next charges which fall under our conſideration; and are blazon'd either *bearded*, *ſeeded*, or *ſlipped*.

Corn is blazon'd either *couped*, *bladed*, *eared*, or in *ſtalks*, or in *garbe* or *ſheaf*, which ſheaf is ſubject to different changes, according to the different metals and colours of *Heraldry*.

The *fleur de lys*, which is the bearing of the kings of *France*, are blazon'd either *or*, *argent*, &c, according to the different ſorts of metals, and colours of *Heraldry*.

Trefoil is blazon'd either *erazed in the ſtalk*, or *ſlipped*; as well as the *cinquefoil*.

Animals are the next in order.

Lions, griffins, wolves, and bears, if exactly in *pale*, are ſaid to be *rampart*; but if ſet more bend-ways, lions, wolves, and bears, are *ſaliant*; griffins, *ſegrant*. Lions are alſo *langued* (i. e. *tongued*) and *armed*, i. e. have their nails of ſome different colour from that of the body. Griffins are armed, *i. e.* their talons are of a different colour from the reſt of their body. Eagles and ſwans *membered*, i. e. when their feet are of a different colour from the reſt of their body. Hawks are *jeſſed* and *balled*; *jeſſed*, when they ſeem to ſpring or ſhoot out of ſome other charge. Cocks are *armed*, *creſted*, and *velloped*. *Creſted* when their *creſt* is different from the reſt of the body. Capons are *armed*, *creſted*, and *jowlopped*.

Lions are moſt commonly borne whole, and then they are either *rampant*, *guardant*, or *rampant-regardant*. When they are ſet more bend ways, they are term'd *ſaliant*. Alſo they are borne *paſſant*, *paſſant regardant*, *ſejant* (or *ſitting*) *couchant* (or *lying*) *dormant* (or *ſleeping*) *jeſſant*, *iſſuant*, and *naiſſant*.

Lions, or any other creature that proceeds from the bottom of a y ordinary, is term'd *iſſuant*; when over two colours, *jeſſant*; when from the middle, *naiſſant*, or *ſwimming*; yet theſe are ſometimes called *demi lions*. A *lion*, or other thing, ſaid to be *unbraled*, is when the ſhape is only ticked out with a pencil, and the field appears through it. *Lions* are ſometimes borne *barry*, *vairy*, *nebulee*, &c.

Stags are blazon'd either *tripping*, *ſtanding at gaze*, *lodged* (when reſting on a mount) *ſpringing forward*, and *currant* (when running). *Bucks*, when their horns are ſpoke of, are ſaid to be *attired*. All creatures that are ſet one paſſing contrary to the other, are ſaid to be *counter paſſant*; if two ſtand face to face upright, they are term'd *combatant*; if back to back, *endorſed*.

Creatures partly borne, as the *head*, *leg*, &c. are either *eraſed* (torn off) or *couped* (cut off) The paw of a lion being called a *gamb*.

When lions, eagles, and other fierce creatures are eating, they are termed *ravening*; but when they appear with flower de luces, *&c.* in their mouth, it may be ſaid *ſwallowing* or *devouring*.

All Fowls are borne *going*, *ſitting*, *ſtanding*, or *volan*, i. e. *flying*. The beeks and feet of cocks, *&c.* are termed *armed*. But eagles feet are called *talons*, they are often borne with two heads, and now and then cloſed, which is when their wings are not ſpread.

Fishes are either term'd *naiant* or *hauriant*. *Nuiant* or *natant*, when drawn in an horizontal poſture, feſſe-wiſe, or traverſly a-croſs the eſcutcheon;

cheon; that being their ſwimming poſture. *Hauriant* when ſtanding upright. When three or four are borne intermixing with each other, it is termed *fretted*.

Beaſts, birds, flowers, or any other thing, when but three in the field, and not ſaid to be in *pale*, in *bend*, or in *feſſe*, they always ſtand two above, and one below; and when there are ſix, three, two, and one. If there be any ordinary in the field, where are three things, it alters not their poſition; but if there be ſix, they are commonly ſet otherwiſe.

Beaſts, birds, flowers, *&c.* when of the colour natural to them, in blazoning, are term'd *proper*.

Martlets are birds always painted without legs, becauſe they never uſe them, although they have them; and *alerions* are birds wanting beaks, legs, and feet.

Furs have alſo a place in *Heraldry*, particularly *ermin*, or *ermine*, which is a white *fur*, powder'd or interſperſed with black ſpots.

It is ſuppoſed to repreſent the ſkin of an animal of the ſame denomination; which ſome will have a *water-rat*, others a ſort of *weeſil*, and others an *Armenian mouſe*. In effect, there is no animal whoſe ſkin naturally correſponds to the *herald's ermine*.

The ſable ſpots in *ermine*, are not of any determinate number, but may be more or leſs at the pleaſure of the painter or furrier.

We call *ermine*, v. g. a *croſs ermine*, a croſs compoſed of four ermine ſpots. It muſt be obſerved, that the colours in ſuch arms are not to be expreſſed, by reaſon neither the croſs nor the arms can be of any colour but white and black.

VAIR is alſo a kind of fur or doubling, conſiſting of divers little pieces, *argent* and *azure*, reſembling a *Dutch* U, or a bell-glaſs.

Vairs have their point *azure*, oppoſite to their point *argent*, and the baſe *argent* to the *azure*.

When there are only two or three *vairs*, the antient Heralds call it *great vair*; and when they are more *ſmall vair*.

It was properly the ſkin of a kind of ſquirrel, called alſo in *French vair*, and in *Latin ſcriveus*; which was white underneath, and dove-colour a-top.

Regularly there muſt be but four rows, or ranks of *vair* in the ſhield; if there be either more or leſs, the number muſt be ſpecified. The ſmalleſt number being three rows, is called *defroy de vair*; and the moſt being five or ſix, is called *menu* or *ſmall vair*.

The *Beffroy* is alſo known by the firſt figure on the dexter ſide of the eſcutcheon, being always of metal, and in form of a belt; whereas that of mere *vair*, is in ſhape of a glaſs.

When a coat is charged, or chequer'd with *vair* it is blazon'd *vairy*, or *vairé*.

When the colours are *argent* and *azure*, or white and blue, it is *very proper*; if it be otherwiſe, the colours are to be expreſly named, *viz. vairy*, of ſuch a colour or metal. *He bears vairy, or, and vert.* This is particularly called *vair compoſed*.

The bearings are likewiſe ſaid to be *vairy*, when they are charged with *vairs*. When chiefs, croſſes, pales, feſſes, *&c.* happen to be *vairy*, the number of ranks are to be ſpecified.

Artificial things have alſo been borrowed by the inventors of the art of *Heraldry*, to make of them charges for their eſcutcheons, as crowns, ſcepters, ſwords, rings, battering-rams, cannons, bows, arrows, ſtirrups, horſe-ſhoes, rowels of ſtirrups, lozenges, fuſils, *&c.* All which charges have the ſame different poſitions in a ſhield, with the *honourable ordinaries*; for they are either placed in chief, in pale, or in point, or ſaltier-wiſe, bend wiſe, or bar-wiſe, *&c.*

There are ſeveral charges, ſingular in their kind, and which are found no where but in *Heraldry*, and have ſcarce any meaning, *viz. fret, compony*, and *gobony*.

FRET is a bearing conſiſting of ſix bars, croſſed, and interlaſſed *fret wiſe*, from the *French* word *fret* in architecture. Some call this the *true lover's knot*; others *Harrington's knot*, becauſe it is their arms, and *nodo firmo* the motto. *Gibbon* is for calling it *heraldorum nodus amatorius*.

When it conſiſts of more than ſix pieces, the number muſt be ſpecified.

COMPONY.—A bordure *compone*, is that form'd or compos'd of a row of angular parts, or chequers of two colours.

Compound or *compoſed*, is alſo uſed in the general for a bordure, a pale, or a feſſe, compoſed of two different colours or metals diſpoſed alternately, ſeparated, and divided by fillets, excepting at the corners; where the junctures are made in the form of a goat's foot.

GOBONY, is the ſame as *compony*.

CHECKY, is where the ſhield, or a part thereof, as a bordure, is checquer'd, or divided into chequers, or ſquares.

Where there is but one row of ſquares, it is not properly called *checky*, but *counter-componed*.

Checky, according to *Colombiere*, is one of the moſt noble, and antient figures in all armory; and ought never to be given but to perſons who have diſtinguiſhed themſelves in war: for it repreſents a cheſs-board, which itſelf is a repreſentation of a field of battle. The pawns and men, placed

on both ſides, repreſent the ſoldiers of the two armies; which move, advance, attack, or retire, according to the will of the two gameſters, who are the generals. But had *Colombiere* been acquainted with *England*, he had known that ſo noble a piece of armory is rendered ſo deſpicable here, as to be made the diſtinguiſhable ſign of an ale-houſe; becauſe, perhaps, it is often made a field of battle, when the knights of malt find themſelves inſpired with a warlike humour.

Checky is always compoſed of metal and colour. Some authors would have it ranked among the ſorts of furs.

When the whole eſcutcheon is chequer'd, it ſhould ordinarily contain ſix ranges; there is no need of blazoning to expreſs them; only it muſt be obſerved to begin to blazon by the firſt ſquare in chief on the dexter ſide; ſo that, if that be *or*, and the next *gules*, the houſe or family is ſaid to bear *checky, or, and gules*.

When the whole ſhield is not checquer'd, but only the chief, a bend, croſs, or the like, the number of ranges ſhould be expreſſed.

Heralds have alſo invented pieces, wherewith they charge their eſcutcheon to diſtinguiſh families, and make a difference between brothers, as alſo to diſtinguiſh legitimate from natural iſſues, or children.

Thoſe pieces are, a *label* of three points for the eldeſt ſon.

A *label* is eſteemed the moſt honourable of all differences, and is form'd by a fillet uſually placed in the middle, and along the chief of the coat, without touching its extremities. Its breadth ought to be a ninth part of the chief. It is adorn'd with pendants, ſomething like the drops under the triglyphs in the dorick freeze. When there are above three pendants, the number muſt be ſpecified in blazoning. There are ſometimes ſix.

A *creſcent* for the ſecond ſon.
A *mullet* for the third ſon.
A *martlet* for the fourth ſon.
An *annulet* for the fifth ſon.
A *flower de luce* for the ſixth ſon.

And they have appointed for the eldeſt ſon of the ſecond houſe, a *label* upon a *creſcent*; the ſecond a *creſcent* upon a *creſcent*; the third a *mullet*, upon a *creſcent*; and ſo on.

And for the eldeſt ſon of a third houſe, a *label* upon a *mullet*, the ſecond a *creſcent* upon a *mullet*, &c. but daughters all bear their father's coat without any difference.

A *baſtard*'s arms ſhould be croſſed with a bar, fillet, or traverſe from the left to the right. They were not formerly allowed to carry the arms of their father, and therefore they invented arms for themſelves. The difference for the king of *France*'s legitimated children, is a *battony pery en barre*.

Having given an exact deſcription of all the different charges of any kind whatſoever an eſcutcheon can be charged with, and of the pieces, which mark the diſtinction of families, and the difference between brothers, I muſt paſs to thoſe which Heralds have placed over the eſcutcheon, to mark the difference of nobility, beginning with the *helmet*.

The HELMET was antiently an armour of defence, wore by the cavaliers, both in war and in tournaments, as a cover and defence of the head; and ſtill uſed by way of creſt or ornament over the ſhield, or coat of arms.

The *helmet* is known by divers other names, as the caſk, head-piece, ſteel cap, *&c.*

The *helmet* cover'd the head and face, only leaving an aperture about the eyes, ſecured by bars, which ſerved as a viſor.

The *helmet* is bore in armory as a mark of nobility; and by the different circumſtances of the bearing of the *helmet*, are the different degrees of nobility indicated. In *France*, the following rules obtain.

A *perſon* newly enobled, or made a gentleman, bears over his eſcutcheon a *helmet* of bright iron or ſteel, in profile, or ſtanding ſideways; the viſor quite cloſe.

A *gentleman* of three deſcents bears it a little open, but ſtill in profile; ſhewing three bars of the viſor.

Antient knights, *&c.* have it in profile, but ſhewing five bars, the edges of ſilver.

A *baron*'s *helmet* is of ſilver, the edges gold; with ſeven bars, neither quite in profile, nor yet in front; with a coronet over it, adorned with pearls.

Viſcounts, and *earls*, formerly bore a ſilver *helmet*, with gold edges, its poſition like the former; but now they bear it quite fronting, with a coronet over it.

Marquiſſes bear a ſilver *helmet*, damaſked, fronting; with eleven bars, and their coronets.

Dukes, and *princes*, have their *helmet* damaſked, fronting; the viſor almoſt open, and without bars; with their coronets over them.

Laſtly, the *helmets* of *kings* and *princes* are all of gold, damaſked, full fronting, and the viſor quite open, and without bars.

The *helmets* of *baſtards* are turned to the left, to denote their baſtardy.

Among the *Engliſh* Heralds, theſe laws are of late ſomewhat varied.—*Leigh* will have the *helmet* in profile, and cloſe, to belong to knights;

but all other authors give it to eſquires and gentlemen.

To a *knight* they aſſign the *helmet* ſtanding right forward, and the bearer a little open.

The *helmet* in profile, or poſited ſideways, and open, with bars, belongs to a nobleman under the condition of a duke.

The *helmet* right forward, and open, with many bars, is aſſigned to dukes, princes, and kings.

Over the *helmet* is placed a *crown*, or *coronet*, different, according to the different degree of nobility, from a *baron* to an *emperor*.

Over the *helmet* of a *baron*, the *Engliſh* Heralds put a *coronet*, which has but ſix pearls, four of them in ſight: the *French* Heralds place a gold circle, adorned with pearls turned round it, in form of necklaces.

Over that of a *viſcount*, a *coronet* ſet full of pearls cloſe to the circle.—And the *French*, one which has but ſix pearls, three of them in ſight.

Over that of an *earl*, a *coronet* of pearls, and ſtrawberry leaves.—And the *French*, one ſet of pearls, cloſe to the circle or ring.

Over that of a *marquis*, a *coronet* of ſtrawberry leaves, and pearls.—And the *French* the ſame.

Over that of a *duke*, a *coronet*, all ſtrawberry leaves.—The *French* the ſame.

Over that of a *prince*, a *coronet* compoſed of croſſes and flower de luces.—The *French* all flower de luces for the princes of the blood.

The *electoral crown*, or *coronet*, is a ſcarlet cap, turned up with ermine, cloſed with a ſemi-circle of gold, all covered with pearls: on the top is a globe with a croſs thereon.

The *Spaniſh crown* is adorned with large indented leaves, covered with diadems, bordering on a globe, ſurmounted with a croſs.

The *Engliſh crown* is adorned with four croſſes, in the manner of thoſe of *Malta*; between which are flower de luces: it is covered with four diadems, which meet at a little globe ſupporting a croſs.

The *French crown* is a circle of flower de luces, encompaſſed with ſix diadems; bearing a-top a double flower de luce, which is the creſt of *France*.

The *Imperial crown* is a bonnet, or tiara, with a ſemi-circle of gold, ſupporting a globe, with a croſs a-top.

In the remoteſt antiquity, the *crown* was only given to gods: *Pliny* ſays, that *Bacchus* was the firſt who uſed it.

The firſt *crowns* were no more than a bandelet or head-band, drawn round the head, and tied behind; as we ſtill ſee it repreſented on medals, around the head of *Jupiter*, the *Ptolemies*, and the kings of *Syria*. Afterwards they conſiſted of two bandelets; by degrees they took branches of trees of divers kinds: at length they added flowers; inſomuch that *Tertullian de Corona* aſſures us (from *Claudius Saturninus* who had wrote expreſly on the ſubject) there was not any plant whereof crowns had not been made. Woods and groves were ſearched to find different crowns for the ſeveral deities.

The *Roman* emperors had four kinds of crowns, ſtill ſeen on medals, *viz.* a crown of laurel, a radiating crown, a crown adorned with pearls and precious ſtones, the fourth a kind of bonnet, or cap.

The firſt was that ordinarily uſed from the time of *Julius Cæſar*: the right of bearing it was granted him by the ſenate; *Juſtinian* was the firſt who took that of the bonnet-kind.

Among the *Romans* there were various kinds of crowns, diſtributed as rewards of military atchievements. The oval crown was the firſt made of myrtle; and was beſtowed on generals who had been victorious over ſlaves or enemies unworthy of the *Roman* valour, and who were entitled to the honour of the leſſer triumph, called *ovation*.

The ſecond was the naval, or roſtral crown, conſiſting of a circle of gold, raiſed with prows and poops of ſhips; given to the captain who firſt grappled, or the ſoldiers who firſt jumped aboard an enemy's ſhip.

The third called *vallaris* or *caſtrenſis*, was alſo a circle of gold, raiſed with piles or palliſades, given him who firſt leaped into the enemy's camp, or forced the palliſades.

The fourth called mural crown, was a circle of gold, indented or imbattled; given him who firſt mounted the wall of a place beſieged, and there lodged a ſtandard. This crown we alſo find given on medals, to the particular genii and guardians of provinces and places.

The fifth the civick crown, made of a branch of green oak; given him who had ſaved the life of a citizen in a battle or an aſſault.

The ſixth was the triumphal crown, made of branches of laurel, given to a general who had gained a battle, or conquered a province. This was afterwards made of gold.

The ſeventh, the *corona obſidionalis*, or *graminea*, made of graſs or herbs found on the ground; given to a general who had delivered a *Roman* army, beſieged by the enemy, and obliged them to decamp.

The eighth was alſo a crown of laurel, given by the *Greeks* to their *athletæ*; and by the *Romans* to thoſe who had negotiated or confirmed a peace with an enemy; this was the leaſt eſteemed. Beſides theſe in antiquity we meet with radial crowns,

given to princes at their tranſlation among the gods, whether before or after their death. *Caſaubon* ſays, this ſort of crowns was peculiar to deities, yet it is certain *Nero* took it in his life-time.

Athletick crowns were deſtined to crown victors at the publick games.

Guliet derives the word *corona*, whence crown, from the *Latin cornu*, horn; becauſe the antient crowns were pointed in manner of horns; which were antiently, both by *Jews* and *Gentiles*, eſteemed as marks of power, ſtrength, authority, and empire. Hence, in the holy ſcriptures, horns are uſed for the regal dignity: and accordingly horn and crown in the *Hebrew*, are expreſſed by the ſame words.

Biſhops and abbots, inſtead of a helmet, place a mitre over their eſcutcheon; the biſhops theirs in front, and that of an abbot in profile. Tho' biſhops in *France*, cauſe to be placed over their eſcutcheon, the coronet borne by their houſe or family, together with the mitre, placed frontwiſe, on the right of the coronet, and the croſier on the left. An archbiſhop, beſides the mitre and croſier, places a double croſs in pale behind his eſcutcheon, the double arms of the croſs, ſurmounting the coronet, and placed in front. The biſhops of the church of *England* content themſelves with impaling their arms with thoſe of their dioceſe, over which is placed a mitre in front.

If the biſhop be a cardinal, the cardinal's *hat* with ſixteen loops is placed over all.

The pope has over his eſcutcheon a *crown* compoſed of a cap or tiara, and a triple *crown* incompaſſing it, having two pendants like the biſhop's mitres; thoſe three *crowns* are ſuppoſed to repreſent the triple capacity attributed to him by the catholicks, viz. as high prieſt, ſupreme judge, and ſole legiſlator of the chriſtians.

The helmet, crown, coronet, *&c.* are alſo often ſurmounted with what is called *creſt*; which is always one of the pieces of *Heraldry*, oftener an animal, or part thereof, than any thing elſe.

Guillim ſays, that next to the mantle, the *creſt* or cognizance claims the higheſt place, being ſeated on the moſt eminent part of the helmet; yet ſo as to admit an interpoſition of ſome eſcrol, wreath, chapeau or hat, crown, *&c.*

The *creſt* of the arms of *England*, a *lion paſſant gardant*, crowned with an imperial crown.

The antient warriors bore *creſts* to ſtrike terror in their enemies, at the ſight of the ſpoils of animals they had killed; or to give them the more formidable mien, by making them appear taller, *&c.*

The *creſt* is eſteemed a greater mark of nobility than the armory, as being bore at tournaments; to which none were admitted till they had given proof of their nobility. Sometimes it ſerves to diſtinguiſh the ſeveral branches of a family: it has ſerved on occaſions, as the diſtinguiſhed badge of factions.

The *motto* of an eſcutcheon, is a ſhort ſentence or phraſe carried in a ſcroll, generally under the arms, alluding to the name of the bearer, ſometimes to the bearing, and ſometimes to neither.

In ſtrictneſs it ſhould expreſs ſomething in the atchievement; but cuſtom has now received whatſoever is the fancy of the deviſer.

Next we will put *ſupporters* to our eſcutcheon, thus charged and adorned; which *ſupporters* are figures in an atchievement, placed by the ſide of the ſhield, and ſeeming to hold or ſupport it.

Supporters are chiefly figures of beaſts; figures of human creatures uſed for the like purpoſes, are more properly called tenants.

Some make another difference between *tenant* and *ſupporter*; when the ſhield is bore by a ſingle animal, it is called *tenant*, when by two, they are called *ſupporters*.

The figures of things inanimated ſometimes placed aſide the eſcutcheons, but not touching, or ſeeming to bear them; though ſometimes called *ſupporters*, are more properly called *cotiſes*.

The *ſupporters* of the *Engliſh* arms are a lion and an unicorn; ſome of the former kings had a leopard and an unicorn, others griffins, and others eagles.

In *England* none below the degree of a banneret are allowed *ſupporters*, which are reſtrained to thoſe called the *high nobility*.—The *Germans* permit none but princes and noblemen of rank to bear them. Among the *French* the uſe is more promiſcuous.

Supporters are always the laſt blazoned.

The eſcutcheon of kings, princes, and dukes, with all its ornaments and *ſupporters*, is wrapped in a *mantle*, which has the appearance of folding of cloth, flouriſhing, or drapery, that is in any atchievement drawn about the coat of arms.

It is ſuppoſed originally to have been the repreſentation of a *mantle*, or military habit worn by antient cavaliers over their armour to preſerve it from ruſt: or as others hold, a ſhort covering only worn over the helmet; which in after-times was lengthened, and made to hang from the helmet below the whole ſhield.

The *mantle* is always ſaid in blazon to be doubled, that is, lined throughout with one of the furs, as ermine, pean, vairy, *&c.*

The *mantle* is ſeldom mentioned in blazoning a coat of arms, and it is not at all neceſſary to do it.

Having

Having thus compleated our *eſcutcheon*, we muſt proceed to the *blazoning* it; which is deciphering it, and naming all the parts thereof in their proper and particular terms; and which cannot be done without having regard to the following rules.

1. The metal, or colour of the field muſt be named firſt. —As *or*, *argent*, or *gules*, &c. 2. The manner of the diviſion of the eſcutcheon by line, whether downright or bendwiſe, and alſo the difference of the line, whether it be indented, ingrailed, *&c.* 3. The charge which is on the field. 4. Having thus expreſſed the field, the diviſion, and the charge, if there be more parts of the field occupied by the charge than one, you are to name the principal part of the field firſt. 5. If there be more than one kind of charge in a field, that in the chief part is to be named firſt. 6. No iteration or repetition of words is to be uſed in blazoning a coat, eſpecially of any of theſe four words, *of*, *or*, *and*, *with*. 7. That there are but two forms of blazon, *viz.* metals and colours. 8. That metal upon metal, and colour upon colour is falſe Heraldry; which admits of no exception but in the arms of *Jeruſalem*, which are, *argent*, a croſs potent between for croſſets, *or*.

Theſe previouſly conſidered, we will begin by *blazoning* the moſt ſimple eſcutcheon, which is always accounted the nobleſt; for the great quantity of different pieces an eſcutcheon is charged with, is not a greater mark of the nobility of the family who bears it.

The arms of the kings of *England*, as kings of *England* only, are very ſimple, and are blazoned, *gules three lions paſſant gardant in pale, or.*

The arms of *Ireland* are but *azure a harp or, ſtrung argent.*

From theſe ſimple eſcutcheons, I'll paſs to thoſe which are charged with more pieces.

The arms of the duke of *Norfolk*, firſt duke, and hereditary earl marſhal of *England*, are blazoned thus in *Engliſh*.—*Gules a band between ſix croſs-croſlets, fiſhee argent, with an augmentation, viz. in the middle of the band an inescutcheon, or, charged with a demi-lion rampant, pierced through the mouth with an arrow, within a double treſſure contre-fleury gules*,—Or thus; *Gules a band argent, charged enceur with a lion rampant, arrowed in the mouth, within a treſſure contre-fleury gules, the band accompanied with ſix croſs-croſlets argent, three and three.*

As the different alliances contracted between noble houſes, ſeldom fail making ſome additions to their eſcutcheons, and engage a family to quarter their arms with thoſe of another, or ſeveral houſes, according as they judge thoſe quarters more capable to honour their own, we muſt give here ſome inſtructions or rules relating to quartering eſcutcheons.

Quartering, in the *French* manner, is to divide the eſcutcheon into four equal parts, by drawing firſt a line perpendicularly from top to bottom, which divides it exactly into two equal parts, and another a-croſs which divides it into two other equal parts, which together make four equal parts or quarters, which is told thus, 1, 2, 3, 4. The quarter on the left, a-top, being the firſt *quarter*; the next to it the ſecond; the quarter on the left at bottom, the third; and the next to it the fourth, or laſt.

If the firſt and the laſt quarter are the ſame coat, they are blazon'd together firſt; and the ſecond and third together, if they be likewiſe the ſame coat; which always happens if there be but two coats in the fourth quarter. For example, in the *French* eſcutcheon, where the arms of *France* are only quartered with thoſe of *Navarre*, the *French* eſcutcheon is the firſt and laſt; and that of *Navarre* the ſecond and third; therefore we blazon it, quartered in the firſt and laſt of *France*; and in the ſecond and third of *Navarre*; naming, if we pleaſe, the different colours and pieces of the eſcutcheon; though there is much more ſkill to blazon an eſcutcheon, which contains ſeveral quarters, in naming the family to which the quarter belongs, than in blazoning the pieces. For example, I ſuppoſe that the arms of the duke of *Norfolk* were quartered with thoſe of that excellent nobleman the viſcount *Montacute Brown*, I would ſay, quartered in the firſt and laſt of *Norfolk*; and in the ſecond and third of *Montacute*.

But perhaps the eſcutcheon thus quartered, contains four different coat of arms; that of the duke of *Norfolk*, of the duke of *Montague*, of the earl of *Harrington*, and of the viſcount *Montacute*; I'll ſay, quartered in the firſt of *Norfolk*, in the ſecond of *Montague*, in the third of *Harrington*, and in the laſt of *Montacute*.

To divide the eſcutcheon into ſix quarters, we draw two perpendicular lines, which divide it into three equal parts, then draw another a-croſs, which divides thoſe three parts into ſix, which parts are told (beginning at the firſt on the left a-top, proceeding to the next to it, from thence to the next to that, which is that on the right a-top, then to the firſt on the left at bottom, from it to the next, ending at that on the right at bottom) 1, 2, 3, 4, 5, 6. This the *French* heralds do not call quartered, but *coupe of three pieces*; for example, the duke of *Ledigueres*, in *France*, *bears coupe of three pieces in chief ſupported with three in point*. In the firſt, or a crequier *gules*, which

which is of *Crequi*. In the ſecond, *or* two lions leoparded *gules*, which is of *Blanche-fort*. In the third, *or* a wolf hauriant *azure*, armed *gules*, which is of *Sault agoult*. In the fourth (which is the firſt of the point) *azure* three towers *or*, which is of *Montauban*. In the fifth, *azure* three pales *or*, a chief of the ſame, which is of *Veſc*. In the ſixth, and laſt, *or* two leopards *azure*, which is of *Montlaur*. And over all of *bonne*, which is *gules*, a lion *or*, the chief couſu *azure*, charged with three roſes *argent*.

The *French* have but this kind of *parti*, which is the ſame as the *Engliſh parti per pale*; the *Engliſh* Heralds applying the word to all the ſorts of partitioning, and never uſe it without ſome addition to ſpecify the particular one intended. Thus they have *parti*, or *parted per croſs*, *per chief*, *per pale*, *per feſs*, *per bend dexter*, *per bend ſiniſter*, *per chevron*, &c.

Parti per pale, is when the chief is divided perpendicularly into two halves, by a cut in the middle from top to bottom. This, and this only, the *French* call *parti*.

Parti per feſs, is when the cut is a-croſs the middle, from ſide to ſide; which the *French* call *coupé*.

Parti per bend dexter, is when the cut comes from the upper corner of the ſhield on the right-hand, and deſcends a-thwart to the oppoſite lower corner; called by the *French*, *tranché*.

Parti per bend ſiniſter, is when the cut coming from the upper left corner, deſcends a-croſs to the oppoſite lower corner one, called by the *French taillé*.

When the ſhield is *parti* and *coupé*, it is ſaid to be quartered, or *ecartele*.

It is ſaid to be *parti* one from the other, when the whole ſhield is charged with ſome honourable bearing, divided by the ſame line that parts the ſhield. Here it is a rule, the one ſide be of metal, and the other of colour.

When the quarters are quartered over again, ſub-divided each into four, this is called by the *French*, *contre-ecartele*, and by the *Engliſh*, *counter-quartered*.

There are counter-quartered coats, which have twenty or twenty-five quarters.

When the quartering is by a ſaltier (which is ſometimes uſed in the *Engliſh* Heraldry) the chief and point are the firſt and ſecond quarters, the right ſide the third, the left the fourth.

In the middle of a *quarter ſhield*, is almoſt always placed the *proper coat* of the *family*, who quarters it with others, which is blazoned over all in *Engliſh*, and *ſur le tout* in *French*, becauſe it covers the two lowermoſt inward corners of the two uppermoſt quarters, and the two uppermoſt inward corners of the lowermoſt quarters.

There has been a great diſpute among the learned, about the origin of arms. *Favyn* will have them to have been from the beginning of the world; *Segoin* from the time of *Noah*; others from that of *Oſiris*, which is ſupported by ſome paſſages in *Diodorus Siculus*; others from the time of the *Hebrews*, in regard arms were given to *Moſes*, *Joſhua*, the twelve tribes, *David*, &c.

Others will have them to have taken their riſe in the heroical age, and under the empires of the *Aſſyrians*, *Medes*, and *Perſians*; building upon *Philoſtratus*, *Xenophon*, and *Quintus Curtius*.

Some pretend that the uſe of arms, and the rules of blazon, were regulated by *Alexander*. Others will have them to have had their original under the empire of *Auguſtus*; others during the inundations of the *Goths*; and others under the empire of *Charlemaigne*.

Chorier obſerves, that among the antient *Gauls*, each man bore a mark on his buckler, by the ſight whereof he might be known to his fellows; and hence he refers the original of the arms of noble families. *Camden* has obſerved ſomething like this of the antient *Picts* and *Britons*, who going naked to the wars, painted their bodies with blazons, and figures of divers colours, which he ſuppoſes to have been different in different families, as they fought divided by kindreds. Yet *Spelman* ſays, that the *Saxons*, *Danes*, and *Normans* firſt brought arms from the north into *England*, and thence into *France*.

Upon the whole, it is certain, that from time immemorial, there have been ſymbolical marks in uſe among men, to diſtinguiſh them in armies, and to ſerve as ornaments of ſhields and enſigns; but theſe marks were uſed arbitrarily as devices, emblems, hieroglyphicks, &c. and were not regular armories like ours, which ſhould be hereditary marks of the nobility of a houſe, regulated according to the rules of *Heraldry*, and authorized by princes.

Before *Marius*, even the eagle was not the conſtant enſign of the *Roman* army, but they bore in their ſtandards a wolf, leopard, or eagle indifferently, according to the fancy of the generals.

The ſame diverſity has been obſerved with regard to the *French* and *Engliſh*; on which account authors are divided, when they ſpeak of the antient arms of thoſe countries. In effect, it appears from all the beſt authors, that the armories of houſes, as well as the double names of families, were not known before the year 1000; and ſeve-

ral have even endeavoured to prove, that the uſe of arms did not begin, till the time of the firſt croiſades of the *chriſtians*, for the conqueſt of the *Holy Land*.

The truth is, it appears to have been the antient tournaments, that occaſioned the fixing of armories. *Henry the fowler*, who regulated the tournaments in *Germany*, was the firſt who introduced theſe marks of honour, which appear to be of an older ſtanding in *Germany*, than any other part of *Europe*. It was then that coats of arms were firſt inſtituted, which were a kind of livery, compoſed of ſeveral bars, fillets, and colours; whence came the feſſe, pale, bend, and lozenge, which were ſome of the firſt elements of armories. Thoſe who had never been concerned in any tournament had no arms, tho' they were gentlemen.

Such of the nobility and gentry as croſſed the ſea, in the expeditions to the *Holy Land*, alſo aſſumed theſe tokens of honour to diſtinguiſh themſelves.

Before theſe times, we find nothing upon antient tombs but croſſes, with *Gothick* inſcriptions and repreſentations of the perſons deceaſed. The tomb of pope *Clement* IV. who died in 1268, is the firſt whereon we find any arms; nor do they appear on any coins ſtruck before the year 1336. We meet with figures, it is true, much more antient, both in ſtandards and on medals; but neither princes nor cities ever had arms in form; nor does any author make mention of blazoning before that time.

Originally none but the nobility had right of bearing arms; but *Charles* V. king of *France*, having enobled the *Pariſians* by his charter, in 1371, permitted them to bear arms: From whoſe example, the moſt eminent citizens of other places did the like.

Camden refers the original of hereditary arms in *England*, to the time of the firſt *Norman* kings. He ſays their uſe was not eſtabliſhed till the reign of king *Henry* III. and inſtances in ſeveral of the moſt conſiderable families in *England*, wherein, till that time, the ſon bore always different arms from the father. About the ſame time it became the cuſtom here in *England*, for private gentlemen to bear arms; borrowing them from the lords of whom they held in fee, or to whom they were the moſt devoted.

Arms, at preſent, follow the nature of titles, which being made hereditary, theſe are alſo become ſo; being the ſeveral marks for diſtinguiſhing of families and kindred, as names are of perſons and individuals.

What relates to the making out arms; the rectifying of abuſes committed therein, *&c.* is chiefly committed to the *king at arms*, whoſe buſineſs beſides is to direct the heralds, preſide at their chapter, *&c.*

There are three *kings at arms* in *England*, viz. *Garter*, *Clarencieux*, and *Norroy*.

GARTER is the principal *king at arms*. — As principal *king at arms*, he has power to make arms, *&c.* And as *garter* he is to attend the ſervice of the order of the *garter*; for which he is allowed a mantle and badge, a houſe in *Windſor* caſtle, and penſions both from the ſovereign and knights; laſtly he has fees. He carries the rod and ſcepter at every feaſt of St. *George*, when the ſovereign is preſent; notifies the election of ſuch as are new choſen; attends the ſolemnity of their inſtallations, and takes care of placing their arms over their ſeats; carries the *garter* to foreign kings and princes; for which ſervice it has been uſual to join him in commiſſion with ſome peer, or other perſon of diſtinction.

Garter's oath relates only to ſervices to be performed within the order; and is taken in chapter before the ſovereign and knights.—His oath as *king at arms*, is taken before the earl marſhal.—This office was inſtituted by *Henry* V.

CLARENCIEUX is the ſecond *king at arms*, thus called from the duke of *Clarence*, to whom it firſt belonged.—His office is to diſpoſe and marſhal the funerals of all the inferior nobility, as Baronets, Knights, Eſquires, and Gentlemen, on the ſouth ſide of the *Trent*.

NORROY, the laſt *king at arms*, is to do the ſame on the north ſide of the river *Trent*.

Theſe two laſt are alſo called *Provincial Heralds*, in regard they divide the kingdom between them into two provinces.

Theſe by charter have power to viſit noblemen's families, to ſet down their pedigrees, diſtinguiſh their arms, *&c.*

Antiently the *king at arms* was created, and ſolemnly crowned by the kings of *England* themſelves; but of later days the Earl Marſhal has a ſpecial commiſſion at every creation, to perſonate the king.

To theſe may be added *Lyon king at arms*, for *Scotland*, who is the ſecond *king at arms* for *Great Britain*; he is inveſted and crown'd with great ſolemnity. To him belongs the publiſhing the King's proclamations, marſhalling funerals, reverſing arms, *&c.*

In *England* they have ſix heralds, *viz. Richmond*, *Lancaſter*, *Cheſter*, *Windſor*, *Somerſet*, and *York*; to which may be added a ſeventh, or *Brunſwick Herald*, inſtituted by King *George* I.

Antiently none could arrive at the dignity of herald, without having been ſeven years purſuivant, who is a gentleman whoſe buſineſs is to attend

attend with the heralds in marſhalling and ordering publick ſolemnities.

Of the great number of purſuivants antiently on foot, there are now only four remaining, *viz. Blue-Mantle*, *Rouge Croix*, *Rouge-Dragon*, and *Portcullice*. Who are the loweſt order of officers belonging to the college of arms.

The heralds, with the *kings at arms*, and the four purſuivants are a college or corporation erected into ſuch by a charter of *Richard* III. who granted them divers privileges; as to be free from ſubſidies, tolls, and all troubleſome offices.

HIEROGLYPHICKS.

HIEROGLYPLICK, a *Greek* compound, which literally imports a ſacred or holy impreſſion or character, is that myſtical figure or ſcience, uſed by the *Egyptian* prieſthood to conceal, and to convey the ſecrets of their divinity. So that *hieroglyplicks* are general accepted to be the ſigns of divine, ſacred, and ſupernatural things: and *ſymbols* are confined to ſenſible and natural things.

The HIEROGLYPHICKS moſt remarkable in the *Egyptian* theology, I have collected in the *copper plate* annexed, and are thus explained: with ſome others.

The *Sun* (Fig. 1) has been often uſed both by the *Pagans* and *Chriſtians*, to ſignify a ſupreme being, and ſome of the *Pagans* have even adored him as ſuch; eſpecially the *Perſians*.

St. *John*, St. *Paul*, St. *Denis* the *Areopagite*, make often a compariſon between God and the ſun.

The *Sun* was alſo the *hieroglypick* of *truth*; nothing more proper than the *ſun* to ſignify *light*, ſince himſelf is the ſource of light.

He was a *hieroglyphick* among the *Romans* of the ſovereign majeſty of the empire.

Archimedes, *lib.* 1. *c.* 36. ſays that he was the *hieroglyphick* of the *human life*: That to ſhew the *tranquility* of that life, he was repreſented in his *full glory*; darken'd and cloudy, to ſignify troubles and inquietude.

The *Sun* was alſo a *hieroglyphick* of the revolution of the whole year, as regulating the ſeaſons by his courſe.

When the *Egyptians* wanted to ſignify a woman with child, or lying in, they repreſented the *ſun* divided in two, with a *Star* in the middle of the diviſion, for a *hieroglyphick* of the child in the womb of its mother; not only becauſe they compared the belly ſituated in the middle of the body to the ſun; but, likewiſe, becauſe they were of opinion that he viviſies all ſorts of conceptions; imagining beſides, that a *ſtar* borrows it lights from the ſun, as a child receives its aliments from its mother.

The *Moon*, (Fig. 2.) was a *hieroglyphick* of *human life*; becauſe its face changes every day, like that of the humane life.

The *Moon* was among the *Pagans*, a *hieroglyphick* likewiſe of *eternity*; becauſe it ſeems to have a perpetual rotation.

For a *hieroglyphick* of the *month*, the *Egyptians* painted the *moon* with her horns downwards.

The *Egyptians* made a *Star* one of the *hieroglypicks*, to ſignify God; becauſe they imagined that the fixed ſtars gave the motion to the inferior heavens, as GOD does to all created beings.

The parts of the human body have been uſed *hieroglyphically*.

The principal *hieroglyphick* of the *Head* has always been to ſignify the *beginning* of ſomething.

A *Head* with a diadem is the *hieroglyphick* of ſovereignty: It is likewiſe the *hieroglyphick* of riches, ſecurity, proſperity, and providence.

The city of *Rome* was repreſented by the head of a woman, with a helmet.

The *Egyptians* ſignified watching, by *two heads*, one of a man looking inwards, and the other of a woman looking outwards, whereby they pretend that the devil had no power to offend them. (*Fig.* 5.)

By the *double head* of *Janus*, prudence and popularity were repreſented.

Some imagine, that the *Janus*'s found in ſeveral places, with two heads, without hands or feet, mounted on a quadrangular column, large a-top, and always going in diminiſhing to the bottom, is the *hieroglyphick* of conſtancy. (*Fig.* 5.)

The interpreters of *Heſiod* are of opinion, that the *Gerion* with *tha heads*, ſignify the moont others the month divided into *nones*, *ides*, and *calends*. Fig. 6.

The *Head* of an *Aſs* on a human body, was the *hieroglyphick* of ignorance.

The *Back* was a *hieroglyphick* of flight.

The *Egyptians* made the *Eye* the *hieroglyphick* of juſtice.

The

HIEROGLYPHICKS.

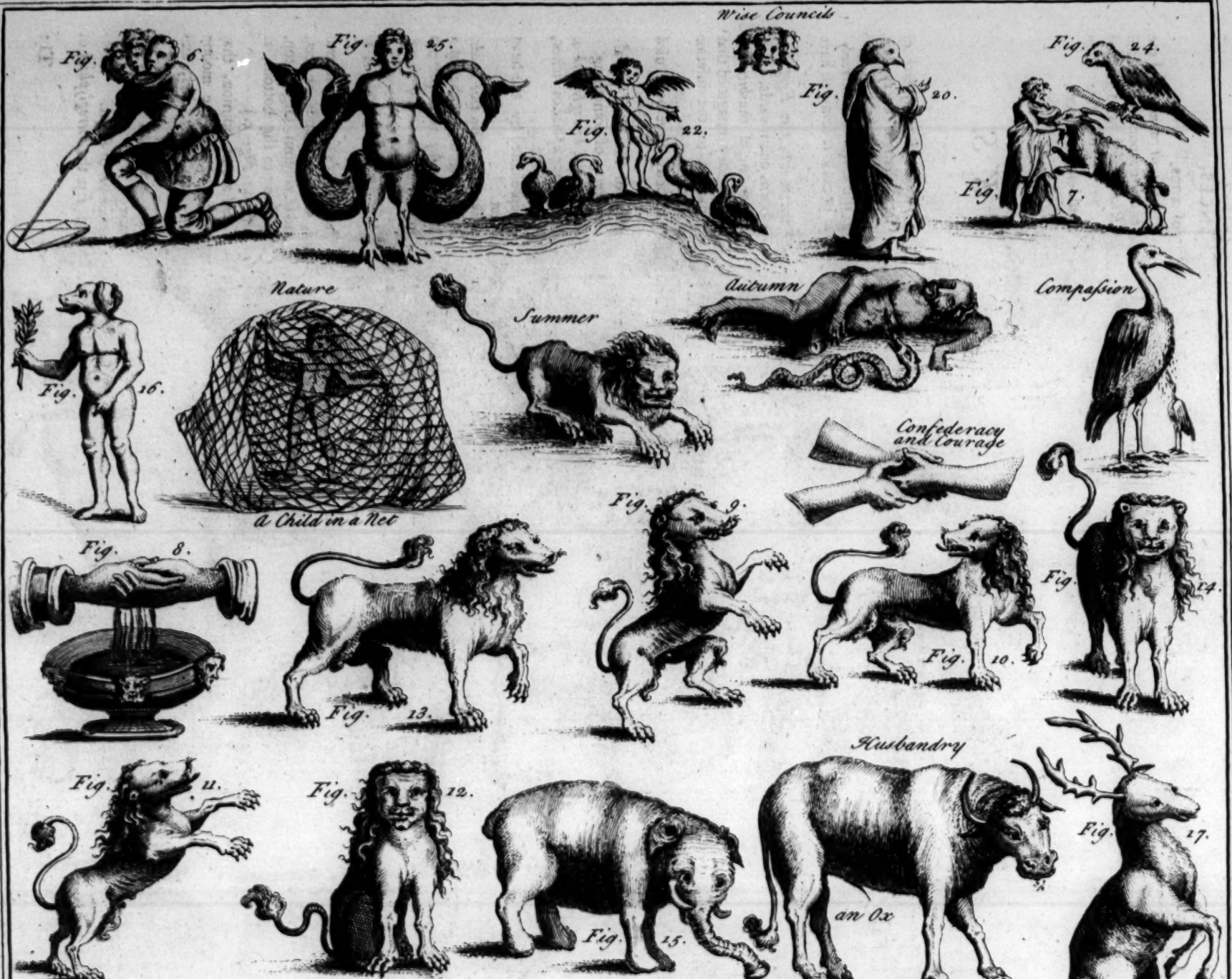


Fig. 15.
Vigilance
a Dog and a Goose
Prosperity
Publick Oppression
Spring a fawning Dog
Calumny
a Month
Palm Tree
Silence
Confederacy
thra Hearts Con cented
a Wolf
Deceit
a Fox
Housenifry
Murther
Impiety
Impurity
Fig. 26.
Fig. 30.
Fig. 28.
Fig. 5.
The World
a Beetle
Prudence
Physick
a Dog's tongue
God
a Falcon
premature Preferment
Sagacity
a Dog's head
Fig. 1.
Fig. 2.
Worthy Prince
a Bee
making honey
Vicissitude
Fig. 27.
Fig. 21.
Musick
Grashopper
God
a Year
The Spirit of the World
Fire
Integrity

R. Cole sculp.

The *Eye* was alſo the *hieroglyphick* of our conceptions.

Eyes without eye-laſhes, was the *hieroglyphick* of a laſcivious perſon.

The *Right-eye open*, ſignified *life*, and the *eye ſhut*, repreſented *death*.

The *eye-brows* ſignified ſeverity.

An *Ear open* ſignified obedience; and an *ear ſtopt* obſtinacy.

A *Tongue*, guided by a hand, repreſented eloquence.

A *Tongue*, on an altar, repreſented ſleep.

Tongues cut, ſignified ſilence. *Iliad.* 3.

Ariſtander, ſays, the *mouth* is a *hieroglyphick* of a houſe, the *teeth* repreſenting the inhabitants.

A *Heart* hanging on the neck ſignified ſincerity.

The *Egyptians*, to ſignify the *inundation* of the *Nile*, repreſented a *heart*, with a *tongue* fixed to it, and repreſented *rage* or *indignation* by a *heart* placed on a *gridiron*.

By a *Back-bone* they ſignified a ſtrong inclination to luxury.

By the *Penis*, repreſented on ſo many pyramids or obeliſks, they gave to underſtand, the valour or courage of the perſons buried under, or near thoſe huge maſſes of ſtones.

The *Matrice*, ſignified a coward.

The antients repreſented *continency*, by a *man* holding his *teſticles* in his *hand*.

The *Navel* was, on ſome medals, a *hieroglyhick* of *Jupiter*.

The *Hand* was an *hieroglyphick* of architecture.

The *Waſhing of Hands* (Fig. 8.) ſignified innocence.

The *Hand* extended, ſignified authority and power.

Both *Hands* in one's boſom, ſignified idleneſs.

The *Hands* tied behind the back, ſignified captivity.

Two *Right Hands joined*, ſignified felicity.

A *Statue without Hands* repreſented a judge, to ſignify that judges ſhould have no hands for bribery or corruption.

The *Feet walking upon the Water*, ſhew'd the impoſſibility of a project.

The *Feet ſet firm on the ground*, indicated a ſtrong foundation.

The *Egyptian* prieſts repreſented the *winter ſolſtice*, by *two feet in fetters*, to ſhew that then the ſun walks ſlower.

Lame, or *diſtorted Feet*, ſignified iniquity.

The *Right Foot* extended, and wrapt up, was an *hieroglyphick* of retreat, or return.

A *Hand* on the *head*, and playing with its fingers, is a *hieroglyphick* of laſciviouſneſs and effeminacy.

The *Thumb* extended downwards, was, among the *Romans*, an *hieroglyphick* of peace. Extended upwards, an *hyeroglyphick* of favour.

The *Index* on the *Mouth*, was a *hieroglyphick* of ſilence.

The *Egyptian* prieſts repreſented the ſtomach by the *middle finger*.

The *Middle Finger* alſo denoted infamy.

The *Annularis* was a *hieroglyphick* of the heart, and for that reaſon the *Egyptian* prieſts uſed to adorn it with a ring, and perfume it. It alſo indicated marriage, ſlavery, and impetration when put to the ear.

I'll paſs to the *animals* which were uſed for hieroglyphick figures, beginning with the *lion*.

The *Lion* alone was among the *Egyptians*, a *hieroglyphick* of the ſtrength of the body.—By the *head of a lion* they underſtood *vigilancy* and *watchfulneſs*.—To ſignify an exceſſive rage, they repreſented a *lion* tearing his own progeny into pieces.

The *Lioneſs* was moſt commonly the *hieroglyphick* of a proſtitute.

A *Lion's Skin*, repreſented virtue.

A *Lion rampant* (Fig. 9.) is the *hieroglyphick* of magnanimity.—*Regardant* (Fig 10.) of circumſpection and caution.—*Saliant* (Fig. 11.) of expedition, or celerity.—*Sejant* (Fig. 12.) of council. *Paſſant* (Fig. 13.) of prudence.—*Gardant* (Fig. 14.) of defence.

The *Sphinx* (which was ſeen at the entrance of ſeveral temples of the antients) with the head of a woman, and the reſt of the body of a *lion*, was a *hieroglyphick* that ſignified, that human nature ſurpaſſes, in excellency, all other animals.

The figure of an *Elephant* (Fig. 15.) was among the *Egyptians*, a *hieroglyphick* to ſignify a king; becauſe perhaps when thoſe animals travel in droves, the eldeſt marches always at the head.

The *Egyptians* repreſented in *hieroglyphick* terms, an *elephant* and a *goat*, to ſignify that a prudent man avoids with care, all that has the leaſt appearance of folly. They painted an *elephant* and a *hog*, to inſinuate that one muſt fly the company of tatlers, as the *elephant* flies the grunting of a *hog*. — To ſignify a king who paſſes his life in luxury and indolence, they painted an *elephant* hunting rats; an occupation very little becoming a body ſo large and ſo heavy.

The *Egyptian* prieſts repreſented a *bull* crowned with the leaves of a fig-tree, for a *hieroglyphick* of modeſty.

The *Athenians* had repreſented a *horſe* on one of their coins, with this legend, ΓΕΡΩΝΟΣ, which was a *hieroglyphick* to ſignify the valour and experience of a hero, in the command of the cavalry.

By a *horſe*, the *Egyptian* prieſts ſignified a profane man.

The *Egyptians* ſignified by a *dog*, a divine, and ſagacity.

Macrobius, *Saturn. c.* 20. ſays, that the figure of a *dog*, was a *hieroglyphick* to ſignify the remembrance of things paſt.

A *Dog* is likewiſe the *hieroglyphick* of fidelity.

The *Egyptians* repreſented under the figure of a *dog*, their God *Anubis*.

They likewiſe underſtood by the *hieroglyphick* of a *dog*, with a diadem or coronet, a prince or legiſlator. A *dog* with a *leading-laſh*, was the *hieroglyphick* of a ſoldier; the *laſh* ſignifying the oath of a ſoldier, and the *dog* his duty.

The figure of a *Man* with the head of a *dog* (Fig. 16) is a *hieroglyphick* of impudence.

A *Hart* chewing the cud (*Fig.* 17.) is a *hieroglyphick* of a man perfectly accompliſhed.

The *Ant* was the *hieroglyphick* of care and induſtry; of foreſight; of conſtancy in toils and labours; of mutual compaſſion; of different offices and manners; of opulence; of vain-glory.

By the *Ant*, and a ſmall bundle of *origan*, the *Egyptian* prieſts ſignified devaſtation.

The *Egyptian* prieſts underſtood by the figure of a *hog*, a dangerous and brutiſh man; by a *hog* wallowing in the mud, an uncivil and ill-bred man, luxury and gluttony.

The *Egyptians* by the figure of a *ſheep*, underſtood folly: likewiſe innocence, good-nature, and meekneſs.

The *Aſs* was a *hieroglyphick* of ſtupidity, and of uncleanneſs.

A *Running Aſs*, was a *hieroglyphick* of a fine enterprize begun, but ſoon neglected; becauſe the galloping of an *aſs* is but ſhort.

The *Egyptians* repreſented the *Mule* to ſignify ſterility.

The *Egyptian* prieſts underſtood by the figure of the *Hare*, vigilancy; and quickneſs of hearing

The *Hare* was alſo a *hieroglyphick* of fecundity; and of ſolitude.

The *Fox* ſignified a deceitful, cunning, treacherous, and malicious man.

By the figure of this animal, the *Egyptians* ſignified a man who had inſulted a woman; becauſe this animal, ſeeing himſelf cloſely purſued, cuts his genitals, and throws them far from him.

The *Mole* is the common *hieroglyphick* of blindneſs; of a quick hearing, and of futurity.

The *Rat* was an *hieroglyphick* of ruin and deſtruction; becauſe they are always gnawing ſomething night and day.

The *Egyptian* prieſts by the *rat*, ſignified choice and option, becauſe of ſeveral eatables, he always chuſes the beſt.

The *Egyptian* prieſts, to ſignify the world, repreſented a *ſpotted ſerpent* biting its tail; pretending thereby to ſhew the immortality of things created, whoſe beginning tends towards its end, and the end returns to the beginning.

By a *Serpent* which had caſt off his ſkin, was ſignified an old man, reſtored to his priſtine juvenility.—By one the tail under his throat, was underſtood time, comparing the revolution of the ſeaſons, to the circumvolutions of the ſerpent.

The figure of a *ſerpent*, with the head of a ſaker, within a braſs hoop, almoſt in the form of the *Greek* letter Θ, ſignified the maſs of the world.

By the figure of the *Baſiliſk*, the *Egyptian* prieſts underſtood a century and eternity.

The figure of the *Baſiliſk* ſignified likewiſe a calumniator.

The *Egyptian* prieſts repreſented the *Viper* to ſignify children who conſpire againſt their parents.

To ſignify a prince inclinable to clemency, they repreſented a *Serpent* in his circumvolutions, and biting his tail. And to ſignify one who had taken a particular care of his people, they repreſented a *ſerpent* with his eyes open, his neck erect, and raiſing up his breaſt.

By the *Caducee*, which is a rod, garniſhed with two ſerpents, male and female, they underſtood the birth of man, and concord and amity.

The *Cornucopia* joined to the *caducee*, ſignified felicity.

The figure of the *Vulture* was made uſe of by the *Egyptian* prieſts, to ſignify the year.

By the *vulture* tearing her thighs to feed her young withal, they repreſented pity and commiſeration.

Plunder is alſo repreſented by the figure of the *vulture*.

The principal ſignification of the *Eagle* was proſperity.

Pindarus deſigns by the *Eagle*, a quick wit.

By the figure of the *Phœnix*, the *Egyptian* prieſts underſtood a reſtoration; becauſe the *phœnix* was ſuppoſed to revive from his own aſhes.

The *Egyptian* prieſts ſignified by the figure of the *Pelican*, an extreme folly; becauſe, when as that bird could build his neſt on the higher places, he builds it on the lower, where his young can be ſtolen away. Likewiſe compaſſion and paternal love; becauſe he is ſuppoſed to open his breaſt, and feed his young with his own blood.

By the figure of an *Owl* placed on an altar, was underſtood *Minerva*; and conſequently wiſdom.

The *Egyptian* prieſts, by the figure of an *owl*, ſignified death.

By the *owl* was likewiſe repreſented tyranny.

By the figure of the *Lanner*, the *Egyptian* prieſts underſtood the ſun. *Zoroaſter* ſays, that God has the head of a *lanner* (Fig. 20.)

By the figure of a *lanner* flying, the *Egyptians* underſtood the ſublimity of thoughts, and likewiſe wit, celerity and quickneſs.

The chriſtians by the figure of a *Dove* underſtood the Holy Ghoſt and divine love, otherwiſe called charity.

The *Egyptian* prieſts underſtood by the figure of the *Swan*, an old man who delights in *muſick*, becauſe the ſwan is ſuppoſed to ſing better the nearer he approaches his end.

The figure of a *Swan* ſignified likewiſe, a man who oppreſſed his countrymen and fellow citizens, (*Fig.* 21.) For the *ſwans* have this peculiar to themſelves, that they fight and eat one another.

There is in the cabinet of curioſities of the great duke of *Tuſcany*, an *Apollo* on marble, who plays on the violin, which he holds in his left-hand, and reſting it on the back of a *ſwan*, which ſeems to touch gently the chords with his beak, as it were to heighten the harmony. This was made for a *hieroglyphick* of muſick, (*Fig.* 22.)

By the figure of the *Parrot* is underſtood *eloquence*, becauſe no other animal imitates ſo well the human voice, (*Fig.* 24.)

The figure of the *Peacock* ſignified *Juno*, becauſe that bird was conſecrated to her. The ridicule and vanity of riches was alſo figured by the feet of the *peacock*, which are deſpicable when compared with the reſt of his body. By the tail of the *peacock*, was ſignified the viciſſitude of fortune, becauſe its fine feathers fall every year at the fall of the leaves, and they begin to ſprout anew in the ſpring following.

The figure of a *Syren* or *Mermaid*, with the feet of a *hen*, ſignified misfortunes, (*Fig.* 25.)

A *Hen* ſignified fecundity, health, and ſecurity.

By the figure of a *Cock* is underſtood the *French* nation.

The *Cock* is alſo the *hieroglyphick* of impiety, becauſe he treads his mother and beats his father.

By the figure of a *Gooſe* holding a pebble in her bill, the *Egyptians* underſtood ſilence kept a propos, and alſo a falſe accuſer.

In ſcripture *irreſolution* is ſignified by the *Oſtrich*.

The *Egyptian* prieſts wanting to repreſent good and loyal ſubjects who loved their prince, painted a *bee*.

By the *Bee* is alſo underſtood chaſtity.

By a *Fly*, the *Egyptians* underſtood importunity, impudence, and obſtinacy.

By a *Spider* is ſignified a needleſs work.

The *Egyptian* prieſts to ſignify *impiety*, *ingratitude*, and *injuſtice*, painted a *Sea-horſe*, and ſignified that piety was preferable to impiety, by the head of a *Caſſowary* fixed on the foot of a *ſea-horſe*, (Fig. 27.)

The *Egyptians* to ſignify a perſon without ſhame painted a *Frog*, becauſe it is ſuppoſed that ſhe has blood no where elſe but in the eyes; and alſo underſtood thereby a needleſs or criminal curioſity.

There was ſeen at *Sais*, on the portal of a temple dedicated to *Minerva*, a *child*, an old *man*, a *falcon*, a *fiſh*, and a *ſea-horſe*, (Fig. 28.) which ſignified the condition and fragility of human life: which from its infancy tends towards old age, and returned again to infancy. By the *Falcon* was underſtood our intellectual faculty, which is a participation of the divinity; death by the *fiſh*, by reaſon of the ſea, which the *Egyptians* called ruin and deſtruction; and violence by the *ſea-horſe*, becauſe he does not even ſpare his own father, whom he kills to enjoy his mother.

The *Egyptian* prieſts, with regard to that beginning and end, which is inviſible, underſtood *God* by the figure of the *circle*.

By the figure of a *circle* we underſtood the courſe of a year, in conſideration of the gold circle which *Cambyſes* carried off from the ſepulchre of *Simond*, and which had in circumference 365 cubits, and a cubit in breadth, each day of the year being engraved on each cubit, according to the diurnal courſe of the planets.

The *winged Sphere* wreathed about with *Serpents*, was the *hieroglyphick* of the ſpirit and ſoul of the univerſe, (*Fig.* 29.)

The *Egyptian* prieſt, by a quadrangular figure, underſtood wiſdom; becauſe they ſuppoſe that form the moſt ſecure foundation.

By the figure of a triangular *Pyramid* or *Obeliſk*, the antients underſtood the *Divinity*; as conſidering the number *three* the moſt perfect number.

The figure of a *Helmet* ſignified war.

By the figure of a *Girdle* the *Greeks*, *Latins*, and *Hebrews* underſtood virginity; alſo ſtrength and virtue.

The figure of a *Ring* was a *hieroglyphick* of faith and honour, and among the *Romans* of nobility.

The *Diadem* ſignified royal power, authority, and victory.

The *Scepter* ſignified a kingdom.

A *Necklace* or gold chain, ſignified a ſolid virtue.

The *Egyptians* to expreſs fame, they painted a *thunder-bolt*. By the figure of a *thunder-bolt*, was alſo underſtood celerity.

An *Anchor*, environ'd with a *Dolphin*, ſignified haſte.

By the figure of a *Ship at anchor*, the *Egyptian* prieſts underſtood a profound ſecurity.

By the figure of a *Rudder* of a ſhip, was underſtood the government of a ſtate.

Yokes, *Chains*, and *Fetters*, ſignify moſt properly the ſtate of marriage. (*Fig.* 30.)

Among the ſeveral *hieroglyphick* ſignifications of the *Palm-Tree*; the following are the four principal; which are, that it ſignifies year, month, juſtice or impartiality, and victory.

Among the ſacred *hieroglyphicks*, by the figure of a *palm-tree* is underſtood innocency and a good life.

The *Laurel* is an *hieroglyphick* of prophecy, health, or preſervation, and of victory.

By the figure of an *Oak*, was ſignified ſometimes the ſtrength of body, and ſometimes length of time.

The figure of a *Cypreſs* ſignified *Words without Deeds*; becauſe the *Cypreſs*, tho' a beautiful tree, produces no fruit.

We ſee on ſeveral antient coins and medals, that the *olive-tree* with a *caduceus*, is an *hieroglyphick* of felicity.

In ſeveral places of the ſcripture, by the *olive-tree* is underſtood alms; it alſo ſignifies clemency, abundance, or plenty, hope, and peace.

By the figure of the *Vine*, the *Egyptians*, and other nations, underſtood joy and mirth, and likewiſe liberty.

HORSEMANSHIP.

HORSEMANSHIP, as a ſcience, inſtructs us in whatever relates to the make, colour, age, temper, and qualities of *horſes*, and their reſpective countries and climates. Likewiſe the knowledge of the defects and diſeaſes of horſes, and the remedies proper for the ſame; with the ſeveral operations relating thereunto, as *docking*, *gelding*, *ſhoeing*, &c.

A HORSE is a domeſtick quadruped, of great uſe in agriculture, commerce, war, ſporting, *&c.* and is the ſubject of the art of *horſemanſhip*.

Horſes are diſtinguiſhed into divers kinds, and differently denominated; either with regard to their *ſtrain*, or *country*, or to their *colour*; or to the *uſes*, or *offices* they are reſerved for.

They are diſtinguiſhed with regard to their *ſtrain*, or *country*; as the *Neapolitan*, known by his hawk noſe; the *Spaniſh Jennet*, known by his ſmall limbs, the *Barbe*, by his fine head and deep hoof; the *Dutch*, by the roughneſs of his legs; the *Engliſh*, by his ſtrong knitting together, *&c.*

With regard to their *colours*; as a *bay*, which admits of divers ſhades or caſts, *viz.* a black *bay*, brown *bay*, dappled *bay*; all which have conſtantly black manes and tails. *Dun*, and *mouſe-dun*, having frequently a black liſt along the back, which denominates them *flea-backed*. *Flea bitten*, which is white ſpotted with red. *Gray*, dappled *gray*, ſilver *gray*, ſad or powder'd *gray*, black *gray*, ſandy *gray*, and iron *gray*. *Griſſel* or *rount*, a light fleſh-colour, intermixed with white. *Peach-colour*, or *bloſſom-colour*. *Pye-bald*, which conſiſts of two colours, one of them white. *Roan*, a bay, black, or ſorrel, intermixed with white hairs. *Rubican*, black, or ſorrel, with white hairs ſcattered about his body. *Sorrel*, common *ſorrel*, red or cow-colour'd *ſorrel*, bright or light-coloured *ſorrel*, burnt *ſorrel*, all chiefly diſtinguiſhed by the colour of their Manes. *Starling-colour*, reſembling a browniſh, or blackiſh grey, only more freckled, or intermixed with white. *Tyger-colour*, much the ſame with the branded grey, only the ſpots ſmaller. *Wolf-colour.—Deer-colour.—Black.—White*, &c.

The colours are generally conſidered as ſymbolical of the nature, qualities, *&c.* of the beaſts; and accordingly their value is much influenced thereby. The *dapple gray*, is prized for *beauty*; the *brown bay*, for *ſervice*; the *black*, with ſilver hairs, for *courage*; the *roan*, for *countenance*; the *ſorrel*, black with white, and iron-gray, are reputed *hot* and *fiery*; the *bright-gray*, *flea-bitten*, and *black* with white ſpots, are *ſanguine*; the *white*, *dun*, and *pye-bald*, *phlegmatick* and *heavy*; the *mouſe-dun*, *red bay*, and *blue gray*, are *dull*: the *peach-colour* rarely proves obedient to the ſpur; the *ſorrel* ſeldom fails of being good, eſpecially if their legs, tails, and manes are black; and the ſame may be ſaid of the *flea-bitten*, at leaſt thoſe ſo marked in the foreparts, or over the whole body; for when only behind, it is an ill ſign.

Yet it is hard laying down any univerſal rules. The *white*, which promiſes the leaſt, proves good, when black about the eyes and noſtrils; and there are excellent *iron-greys*, though they are not reputed a good colour.

With regard to the *uſes* or *offices* they are reſerved for, horſes are diſtinguiſhed into *coach-horſe*, *war-horſe*, *hunting-horſe*, *running-horſe*, *pack-horſe*, &c.

The two former diſtinctions contribute much towards the knowledge of a horſe; but one of the moſt eſſential points of that knowledge, conſiſts in the age; the horſe being an animal, that remarkably ſhews the progreſs of his years, by correſpondent alterations in his body.

We have characteriſticks from his teeth, hoofs, coat, tail, and eyes.

The

The *firſt year* he has his foal's teeth, which are only grinders and gatherers: the *ſecond*, the four foremoſt change, and appear browner and bigger than the reſt: the *third*, he changes the teeth next to theſe; leaving no apparent foal's teeth, but two on each ſide above, and two below: the *fourth*, the teeth next to theſe are changed, and no foal's teeth are left, but one on each ſide, above and below: At *five years*, his foremoſt teeth are changed, and the tuſhes on each ſide are compleat: thoſe which come in the places of the laſt foal's teeth, being hollow, and having a little black ſpeck in the midſt; which is called, *the mark in a horſe's mouth*, and continues till eight years of age: at *ſix years*, he puts up new tuſhes; near which appears a little circle of young fleſh, at the bottom of the tuſh; the tuſhes withal being white, ſmall, ſhort, and ſharp: at *ſeven years*, the teeth are all in their growth, and the mark in the mouth appears very plain: at *eight* years, all his teeth are full, ſmooth, and plain, and the mark ſcarcely diſcernable; the tuſhes looking yellowiſh: at *nine years*, the foremoſt teeth ſhew longer, yellower, and fouler than before; and the tuſhes become bluntiſh: at *ten years*, no holes are felt on the inſide of the upper tuſhes; which till then are very ſenſible: add that the temples begin to be crooked and hollow: at *eleven years*, his teeth are very long, yellow, black, and foul; but he will cut even, and his teeth ſtand directly oppoſite to one another: at *twelve years*, the upper teeth hang over the lower: at *thirteen*, the tuſhes are worn cloſe to his chaps, if he has been much rode; otherwiſe they will be black, foul, and long.

As to the *hoof*; if it be ſmooth, moiſt, hollow, and well-ſounding, it is a ſign of youth: on the contrary, if rugged, and as it were ſeamed, one ſeam over another, and withal dry, foul, and ruſty, it is a mark of old age.

For the *tail*; taking him by the ſtern thereof, cloſe at the ſetting on to the buttock, and griping it between the finger and thumb; if the joint be felt to ſtick out more than the reſt, the bigneſs of a nut, the horſe is under ten; but if the joints be all plain he may be fifteen.

The *eyes* being round, full, and ſtaring; the pits that are over them filled, ſmooth, and even with his temples; and no wrinkles to be ſeen, either under or above, is a mark of youth.

The *ſkin* being plucked up in any part betwixt the finger and thumb, and let go again; if it returns ſuddenly to its place, and remains without wrinkles, he may be accounted young.

A dark coloured horſe, growing grizzly above the eye brows, or under the mane; or a whitiſh horſe growing mackled, either white or black, all over, may be infallibly concluded extremely aged.

Laſtly; a horſe being young, the bars of his mouth are ſoft and hollow; otherwiſe they are deep and feel hard, and rough.

The maſters in this art lay it down, that a horſe to be good and well made, muſt have three parts like thoſe of a woman, *viz.* the breaſt, which is to be broad, the hips round, and the mane long: three of a lion, *viz.* countenaace, intrepidity, and fire: three of a bullock, *viz.* the eye, noſtril, and joint: three of a ſheep, *viz.* the noſe, gentleneſs, and patience: three of a mule, ſtrength, conſtancy, and foot: three of a deer, head, leg, and hair ſhort: three of a wolf, throat, neck, and hearing: three of a fox, ear, tail, and trot: three of a ſerpent, memory, ſight, and turning: three of a hare or cat, running, walking, and ſuppleneſs.

The ſkin and coat of the horſe, is the *hair*: the long hair on the neck, the *mane*: the fore-top, the *topping* or *tuke*: the hair behind, on the feet, the *fetlock* or *fetter*: that growing over the top of the hoof, the *coronet* or *cornet*: that on the eye-lids, the *brills*. The ridge whereon the mane grows, is called the *creſt* or *criſt*: the fore-part, from the neck to the fore legs, the *briſket* or *cheſt*: the mark frequently running down his face, the *rath*; and that in the forehead, the *ſtar*. The top of the ſhoulder, at the ſetting on of the neck, is called the *withers*: the place where the ſaddle is ſet, the *dock*; and a bruiſe or hurt thereon, a *navel gall*: the middle of the back, from the mane to the hips, the *reins*: the extremity of the reins above the hips, the *croupe*: the tail, the *dock* or *runt*: the hollow or ſinking of the back-bone, the *ſway*: the hind part of the belly, next the genital, the *flank*: that nearer the thighs, the *groin*: the looſe ſkin wherein the yard is, the *ſheath*; and the fore-part of the ſhoulders, next the breaſt, the *fillets*; the uppermoſt part of the hind leg, next the buttock, is called the *ſtiffle* or *ſtiffle joint*: the after-joint, or bending of the hind-leg, the *chambrel* or *elbow*: the inner, the *ham*, or *hough*: the joint at the fetlock, the *paſtern*, *ankle*, or *fetlock joint*: the foot, above the hoof of the ankle joint, the *coronet*. The part from the withers to the top joint of the thigh, is called the *ſhoulder*: the middle joint of the fore leg, the *knee*: the right leg before, the *farther leg*; and the left, the *nearer*. The hoof is called the *horn*: the hollow of the hoof, the *coffin*: the tender part of the hoof, next the heel, the *fruſh*: the ball of the foot, the *frog*: the part to be pared, or cut off the hoof, when over-grown, the *riſt*: the fore-part of the hoof, the *toes*: the hind-part, where there is a riſing in the middle of the ſole, the *heel*; and the inſide, meeting on the heel, the *quarters*.

The

The principal article of the art of *breeding horſes*, conſiſts in the choice of the *ſtallion* and *mare*; ſince on this depends chiefly the goodneſs of the breed.

It is the common opinion, that the beſt *ſtallion* is either an *Arabian* horſe, a *Spaniſh*, a *Turk*, or a *Barbary*, that is well ſhaped, and of a good colour.

The fitteſt *mare* to breed out of (according to the duke of *Newcaſtle*) is one that has been bred of an *Engliſh* mare, and a *ſtallion* of the above-mentioned races; but if ſuch a *mare* is not to be got, choice muſt be made of a right bred *Engliſh* mare, by ſire and dam, that is well fore-handed, well underlaid, and ſtrong put together in general; and in particular, ſee that ſhe has a clean head, wide noſtrils, open chaul, a big weaſand, and the wind-pipe ſtrait and looſe; and chuſe her about five or ſix years old; taking care, likewiſe, that the *ſtallion* be not too old.

A *ſtallion* muſt be kept as high as poſſible, for four or five months, before the time of covering, with old clean oats, and ſplit beans, well hulled; to which you may add, if you pleaſe, bread; and now and then, for change of diet, you may give him a handful of wheat or oats waſhed in ſtrong ale. Mr. *Morgan*, in his perfection of *horſemanſhip*, adviſes to mix bay-ſalt and anniſeed with his provender; which others think needleſs, while the horſe is in health; but he muſt have plenty of good old ſweet hay, well cleanſed from duſt; and good wheat ſtraw to lie on; watering him twice every day, at ſome fair running ſpring, or elſe a clear ſtanding pond-water, near ſome meadow or level piece of ground, where you may gallop him after he has drank. When you have brought him to the water, do not ſuffer him to drink his fill at firſt, but after his firſt draught, gallop and ſkip him up and down a little, to warm him; and then bring him to the water again, and let him drink as much as he pleaſes, after which gallop him as before, never leaving the water till you will find he will drink no more. By this means, new crudities are prevented, which the coldneſs of the water would produce to the detriment of the ſtomach, if he had been permitted to drink his fill at firſt; whereas, in allowing him his fill at laſt, thus by degrees, his body is kept from drying too faſt.

When the *ſtallion* is in his luſt, and the time for covering is come, which is beſt in *May*, that the foals may fall in *April* following (otherwiſe they will have little or no graſs, if they ſhould be put together, according to *Markham*'s opinion, in *March*, though he holds that a foal falling in *March*, is worth two falling in *May*, 'becauſe, ſays he, 'he poſſeſſes, as it were, two winters in a year, and 'is thereby ſo hardened, that nothing afterwards 'can almoſt impair him.') The time, ſays I, being come to put your *ſtallion* and *mares* together, you muſt pull off his hind ſhoes, and lead him to the place where the ſtudd of the *mares* is, which you intend for covering. You ought not to give him above ten or twelve *mares* in a ſeaſon, to the utmoſt; otherwiſe you will ſcarce recover him againſt the next year covering-time.

When your *ſtallion* is paſt this uſe, then buy another; never making uſe of a horſe of your own breed, otherwiſe the beſt kind would in time degenerate; but you cannot do better, ſays the duke of *Newcaſtle*, than to let your own *mares* be cover'd by their ſire; and by this means they are nearer, one degree, to the purity and head of the fountain, from which they are derived, ſince a fine horſe got them, and the ſame fine horſe covers them again.

The method of covering in hand is moſt approved, and which is this:—When they have brought both their *horſe* and *mare* by art and good feeding, to a proper condition for breed, they ſet ſome ordinary ſtoned nag by her, for a day or two to woo her, and by that ſhe will be ſo proned to luſt, that ſhe will readily receive their *ſtallion*; which they preſent to her, either early in the morning, or late in an evening, for a day or two together, and let him cover in hand once or twice, if they think proper, at each time, obſerving always to give the horſe the advantage of ground, having ſomebody ready with a bucket of cold water, to throw on the mare's ſhape, immediately on the diſmounting of the horſe, which will make her retain better the ſeed received; for which purpoſe, they get on her back and trot her for about a quarter of an hour, avoiding, at the ſame time, from heating or ſtraining her; and taking care, after every act, to let them faſt two hours, and then giving each of them a warm maſh.

As to the manner of keeping the *mares*, during the time of their being with foal, and at their foaling, you muſt take care to houſe them all the winter, and to keep them well, their colts will prove the better. When they are foaled, let them run with their dams till *Martinmaſs*, then wean them, and keep them in a convenient houſe, with a low rack, and manger on purpoſe; litter them well, and feed them with good hay, and oats and wheaten-bran mixed, which will make them drink and belly well. The firſt year, you may put them all together, but afterwards they muſt be ſeparated, the ſtone-colts from the fillies; and if you have choice of horſes, you may put yearings together, two years old.

In a warm fair day, you may grant them liberty to run and skip, in ſome incloſed court or back-ſide, taking care to put them up again carefully, that

that they be not hurt. When ſummer is come, and there is plenty of graſs, put them out in ſome dry ground, that has convenient watering, and ſo let them run till *Martinmaſs* again: then houſe them as before, and order them in all points as older horſes, till they are full five years old; then take them up for good, and let your groom back them, if he has ſkill, or elſe ſome ſkilful rider. You may, if you pleaſe, break your fillies, at two years and a half old, and let them be cover'd at three; and by that means they will be ſo tame and gentle, as not to injure themſelves, or their foals. But in caſe of ſickneſs, or any other accident, as lameneſs, *&c.* you muſt then commit them to the Farrier's care.

The reaſon why it is propoſed to houſe them every winter, with dry feeding and lodging, is, that they may be the more like their ſire in beauty and ſhape. For the primary cauſe of the fineneſs of the ſhape and beauty in horſes, is heat, and dry feeding. And this is proved from the ſeveral races already mentioned, *viz.* the *Spaniſh*, *Barb*, and *Turkiſh* horſe, all which countries are under a hot climate, and by conſequence afford little graſs; therefore in our more moderate and cold countries, we are to aſſiſt nature by art, and to ſupply the want of heat by warm houſing, and dry feeding.

A ſtone-horſe is ſeldom kept entire, but to ſerve for a ſtallion. He is moſt commonly gelt, when deſigned for any other uſe.

In *gelding* of horſes, regard muſt be had to their age, the ſeaſon of the year, and the ſtate of the moon.—For the firſt, if it be a colt, the operation may be performed at nine or fifteen days old, if the teſticle be come down; in regard the ſooner he is gelt, the better it will be for his growth, ſhape, and courage; though the horſe may be gelt at any age if care be taken in the cure. As for the ſecond, the beſt time is about *April* or *May*; or elſe about the latter end of *September*. For the third, the wane of the moon is the fitteſt time.

The manner of *gelding* is thus: the beaſt being caſt on ſome ſoft place, the operator takes the teſticles between his fore and great finger, ſlits the cod, and preſſes out the ſtones; then with a pair of nippers, made very ſmooth, either of ſteel, box, or braſil, claps the ſtring of the ſtones between them, very near to where the ſtones are ſet on; and preſſes them ſo hard, that there may be no flux of the blood; then ſears away the ſtone with a thin, drawing cauterizing iron, made red-hot.

This done, he takes a hard plaiſter, made of wax, roſin, and waſh turpentine melted together, and melts it on the head of the ſtrings with the hot iron; and afterwards ſears the ſtrings, and melts more of the ſalve, till there is a good thickneſs of it laid on the ſtrings.

This being done to one ſtone, the nippers are looſened, and the like is done to the other; and the two ſlits of the cod filled with white ſalt; and the outſide of the cod anointed with hog's greaſe; and thus they let him riſe, and keep him in a warm ſtable, without tying him up.

If he ſwells much in his cod, or ſheath, they chaſe him up and down, and make him trot an hour in a day, and he ſoon recovers.

A *hunter* ſhould have a lean, large, and long head; a thin and open chawl; ſmall and pricked ears, or if they be ſomewhat long, provided they ſtand upright, like thoſe of a fox, it is uſually a ſign of mettle and toughneſs; a long and broad forehead, not flat, and as we term it, mare-face, but riſing in the midſt like that of a hare, the feather being placed above the top of his eye, the contrary being thought by ſome to be a token of blindneſs. His eyes ought to be full, large, and bright; his noſtrils wide and red within, for an open noſtril betokens a good wind; his mouth large, deep in the wykes and hairy; his thropple, weaſand, or wind-pipe big, looſe, and ſtrait, when he is rein'd in by the bridle; for if when he bridles, it bends in like a bow (which is called cock thropple) it very much hinders the paſſage of his wind. His head muſt be ſet on to his neck, that there may be a ſpace felt between his neck and his chawl; for to be bull-necked is uncomely to ſight, and prejudicial to the horſe's wind. His creſt ſhould be firm, thin, and well rais'd; his neck long, and ſtrait, yet not looſe and pliant, which the northern men term withy-cragged; his breaſt ſtrong and broad, his cheſt deep, his chine ſhort, his body large, and cloſe ſhut up to the huckle-bone; his ribs round like a barrel, his belly being hid within them; his fillets large, his buttocks rather oval than broad, being well let down to the gaſcoins; his chambrels upright, and not bending, which is called by ſome feckle-houghed, though ſome hold it a ſign of toughneſs and ſpeed. His legs clean, flat, and ſtrait; his joints ſhort, well knit and upright, eſpecially betwixt the paſterns and the hoofs, having but little hairs on his fetlocks; his hoofs black, ſtrong, and hollow, and rather long and narrow, than big and flat. And laſtly, his main and tail ſhould be long and thin, rather than thick, which is counted by ſome a mark of dulneſs.

As to the colour and marks, ſome are rather inclined to believe them grateful to the eye, than an infallible ſign of goodneſs. Yet one may for ornament ſake, and to pleaſe one's eye, make choice of a horſe that is either a brown bay, dapple bay, black, fad-cheſnut, with flaxen mane and tail, ſo that they have either a white ſtar, blaze, or ſnip, with a white foot; dapple grey, or white lyard

with

with black muzzle, eye, and ear. Any of theſe are reputed by moſt men, to give a grace to ſhape, though in themſelves they are no perfect ſigns of goodneſs,

No doubt but the internal qualities of a horſe, are preferable to all the external ones. Thoſe internal qualities are, his being of a gentle diſpoſition to his keeper, tractable and docile, free from thoſe ill qualities of biting, ſtriking, reſtiffneſs, lying down in the water, ſtarting, running away with his rider, plunging, leaping, *&c.* Not but that moſt, if not all theſe ill habits may be rectified by art.

Therefore ſince art was invented to perfect nature, if, notwithſtanding your care, you have a horſe ſubject to any bad qualities, you muſt ſearch into the cauſes of it, which art will help you to recover and remove; and then the cauſe being taken away, the effect will ceaſe.

It is proper your horſe ſhould be five years old, and well weighed before you begin to hunt him; for though it be a general cuſtom, even among the moſt noted horſemen, to train their horſes up to hunting at four years old, and ſome ſooner; yet at that age, his joints not being full knit, nor he arrived at his full ſtrength and courage, he is diſabled from performing any matter of ſpeed and toughneſs; and indeed being put to ſore labour and toil ſo young, he runs a very great hazard of ſtrains, and the putting out of ſplents, ſpavins, curbs, and windgalls, beſides the daunting of his ſpirit, and abating his natural courage; inſomuch that he will grow melancholy, ſtiff, and rheumatick, and have all the diſtempers of old age, when it might be expected he ſhould be in his prime.

Your horſe then being full five, you may, if you pleaſe, put him to graſs, from the middle of *May* to *Bartholomew-tide*, or at leaſt from the middle of ſummer to that time. Take care to provide a good ſtable for his reception, at his taking up; and a good groom to look after him.

The *ſtable* muſt be ſituated, if poſſible, in a very good air, and upon hard, dry, and firm ground, that, in winter, the horſe may go out, and come in clean. It ſhould alſo be ſeated on an aſcent, that the urine, foul water, or any wet, may run thro' trenches, or ſinks cut for that purpoſe. No hen-houſes, hog-ſties, houſes of eaſe, or any other filthy ſmell, is to be ſuffered near it; for hen-dung or feathers ſwallowed, often prove mortal, and the bad air of a jakes is as often the cauſe of blindneſs. Likewiſe the very ſmell of ſwine will frequently breed the farcy; and no animal delights more in cleanlineſs, or is more offended at unwholſome ſavours, than the horſe. The floor (meaning that part on which the horſe is to ſtand or lie down) is to be made of oaken planks not pitched, being eaſier and warmer for him to lie on boards than on ſtones; laying thoſe planks level, for if they were laid higher before than behind, his hind legs would ſwell, and he could never lie at eaſe, his hind parts ſtill ſlipping down. The planks are alſo to be laid croſs-ways, and not at length, and underneath them a trench is to be ſunk, which receiving the urine through the holes bored on purpoſe in the planks, may convey it into ſome common receptacle. The ground behind him ought to be raiſed even with the planks, that he may continually ſtand on a level; the floor behind him well paved with pebble, and that part of the ſtable where the rack ſtands well wainſcotted.

If the ſtable is to contain ſeveral horſes, it muſt be divided into as many ſtands or ſtalls as it will contain horſes, raiſing each partition, which is to be of boards to that height towards the manger, that one horſe may not moleſt the other, and leaving to each horſe room enough to turn about in, and lie down at pleaſure.

The ſtable ſhould likewiſe have preſſes with pegs in them to hang up ſaddles, bridles, houſing-cloaths, *&c.* and alſo ſhelves to place curry-combs, bruſhes, duſting-cloaths, ointments, waters, or any other neceſſaries.

The ſtable muſt have a cieling, that no duſt from above fall upon your horſes: it muſt likewiſe be fitted with a dung-yard, pump, and a conduit, and have, if poſſible, a pond, or running river near at hand. Never leaving the front of the ſtable without litter, that by frequent practice the horſes may learn to empty their bladder when they come from airing.

A *groom* ſhould have the following good qualities:—Firſt, he muſt love his horſes, and endeavour, by good uſage, to make himſelf loved and obeyed by them. He muſt beſides be patient, for nothing is more tractable than a horſe, if uſed kindly. He muſt keep his ſtable clean and in order, and alſo his ſaddles, houſing-cloaths, ſtirrups, leathers, and girts; but above all, his horſes, by dreſſing and rubbing them often. Diligence is abſolutely requiſite in the diſcharge of his duty, and he muſt obſerve even the ſmalleſt alteration, either in his horſe's countenance, as ſymptoms of ſickneſs, or in his limbs and gait, as lameneſs; or in his appetite, as forſaking his meat, and immediately upon any ſuch diſcovery to ſeek out for remedy.

The firſt buſineſs of the groom, after the hunter is ſtabled, is in the morning to water him, and then rub over his body with a hard whiſp a little moiſtened, and afterwards with a woollen cloth; then to clean his ſheath with his wet hand from all the duſt it had contracted during his running, and to waſh

his

his yard with water, then he may trim him according to the manner other horſes are trimmed, except the inſide of his ears, which ought not to be meddled with, for fear of making him catch cold.

This doue, he muſt ſend for the farrier, who is to get him a ſet of ſhoes fitted to the ſhape of his feet, without paring, leaving it well open between the quarter and the thruſh, to prevent hoof-bindt ing, taking care that the opening be ſtrait and no-ſide-ways, for by that means in two or three ſhoeings his heels, in which conſiſts the ſtrength of his feet, will be cut quite away. His foot muſt be pared as hollow as poſſible, to hinder the ſhoe from preſſing upon it. The ſhoes muſt come near the heel, yet not be ſet ſo cloſe as to bruiſe it, nor yet ſo open as to catch in his ſhoe, if at any time he happens to over-reach, and ſo hazard the pulling them off, the breaking of the hoof, or the bruiſing of the heel. The webs of his ſhoes muſt be neither too broad nor too narrow, but of a middle ſize, about the breadth of an inch, with ſloped ſpunges, and even with his foot; for tho' it would be for the advantage of the travelling horſe's heel, to have the ſhoe a little wider than the hoof on both ſides, that the ſhoe might bear his weight, and not his foot touch the ground; yet the *hunter* being often forced to gallop on rotten ſpungy earth, to have them large would hazard laming, and pulling off his ſhoes.

The farrier muſt take a particular care that he pricks not the horſe, but leave a ſpace at the heel of the fore-feet, and a ſpace between the nails at the toe. When the ſhoe is ſet according to this direction, you'll find a great deal of his hoof left to be cut off at his toe. When that is cut off, and his feet ſmoothen'd with a file, he will ſtand ſo firm, and his feet will be ſo ſtrong, that he'll tread as boldly on ſtones as on carpet-ground.

There are ſeveral ſorts of *horſe-ſhoes*, as the *planch ſhoe*, which is ſaid to make a good foot and a bad leg; as cauſing the foot to grow beyond the meaſure of the leg. It is choſe for a weak heel, and will laſt longer than any other ſhoe, being borrowed from the moil, which has weak heels, and ſruſhes to keep the feet from ſtones and gravel.

Shoes with calkings, which, though intended to ſecure the horſe from ſliding, yet are reputed by many to do him more harm than good, in that he cannot tread evenly upon the ground, whereby many times he wrenches his foot, or ſtrains ſome ſinew, eſpecially upon ſtony ways, where ſtones will not ſuffer the calkins to enter. *Double calkins* are leſs hurtful, as he treads evener with them than on the ſingle calkins; but then they muſt not be over-long or ſharp-pointed, but rather ſhort and flat.

Shoes with rings, firſt invented to make the horſe liſt his feet up high; though ſuch ſhoes are more painful than helpful, beſides the unhandſomeneſs of the ſight. This defect is moſt incident to horſes that have not ſound hoofs; for tender feet fear to touch the ground that is hard: but what is intended for remedy proves a prejudice to the horſe, by adding high calkins or rings to his *ſhoes*, as by that means his heels are made weaker than before.

Shoes with ſwelling welts, or *borders* round about them, are uſed in *Germany*, &c. which being higher than the heads of the nails, ſave them from wearing.—Theſe are the beſt ſort of laſting ſhoes, if made of well-temper'd ſtuff, as they wear equally in all parts, and the horſe treads evenly upon them. —Others who uſe to paſs mountains, and places where ſmiths are not ſo eaſily met with, carry ſhoes about them, with vices, whereby they faſten them to the horſe's hoofs, without the help of the hammer or nail; yet this is more for ſhew than ſervice; for though ſuch ſhoe may ſave a horſe's feet from ſtones, yet it ſo pinches his hoof, that he goes with pain, and perhaps injures it more than the ſtones do. — On ſuch emergent occaſions, therefore, it were better to make uſe of the *Joint ſhoe*, which is made of two pieces, with a flat rivet nail joining them together in the toe, ſo that it may be taken both wide, or narrow, to ſerve any foot.

Panton, or *pantable ſhoe*, which opens the heels, and helps hoof binding.—To which may be added the *half panton ſhoe*.

Patten ſhoe, is uſed for a horſe that is burnt in the hip, ſtiffle, or ſhoulder, as it cauſes him to bear upon that leg the grief is on, and conſequently makes him uſe it the better.

When the horſe has evacuated all his graſs, and his ſhoes are ſo well ſettled to his feet, that he may be fit to be rid abroad without danger of ſurbating, you muſt viſit him early in the morning, that is to ſay, by five a clock in ſummer, and ſix in winter; and having put up his litter under his ſtall, and cleanſed the ſtable, the next thing to be done is to feel his ribs, his chaul, and his flank, whereby the good or bad ſtate of his body is diſcernible. If by laying your hands on the lower part of his ſhort ribs, near the flank, you feel his fat to be exceeding ſoft and tender, and to yield, as it were, under your hand, you may be ſure that it is not ſound, and that the leaſt violent labour or travel will diſſolve it; and when diſſolved, before it be hardened by good diet, if it be not then removed by ſcouring, the fat or greaſe belonging to the outward parts of the body will fall down into his heels, and ſo cauſe goutineſs and ſwelling; which diſtempers are both to be prevented and cured. For, if by

feeling his ribs you have found his fat ſoft, you muſt likewiſe feel his chaul, and if you find any fleſhy ſubſtance, or big round kernels, or knots, you may be ſure that as his outward fat is not ſound, ſo inwardly he is full of glut, and purſive, occaſioned by groſs and tough humours cleaving to the concavities of the lungs, and ſtopping his wind-pipe in ſuch a manner, that his wind cannot find a free paſſage, nor his body be capable of much labour. Theſe diſtempers are remedied by feeding him with wholſome food to harden his fat, by moderate exerciſe, warm cloathing, and gentle phyſick, to cleanſe away his inward glut, that his wind and other parts being freed from all groſs humours, his courage, and activity may be thereby heightened.

Till your horſe be thoroughly purged, his flank will likewiſe feel thick to your gripe; otherwiſe it feels but like two thin ſkins.

Theſe remarks made, the groom muſt ſift his horſe a handful or two of good old oats. When he has eaten them, he muſt pull off his collar, and rub his head, face, ears, and nape of the neck with a clean rubbing cloth, which helps towards diſperſing all the humours which often gather in thoſe parts: then waſhing a ſmall ſnaffle in fair water, he will put it on his head, drawing the reins through the headſtall, to prevent ſlipping it over his head. Then taking in his right-hand a curry-comb, ſuitable to the ſkin of his horſe; (*i. e.* if the coat of his horſe be ſhort and ſmooth, the curry-comb muſt be blunt; but if long and rough, then its teeth muſt be long and ſharp) he ſtands with his face oppoſite to the horſe's face, and holding the left cheek of his head-ſtall in his left-hand, curries him hard, from the root of his ears, all along his neck to his ſhoulders: then goes over all his body with a more moderate hand, currying his buttocks down to the lower cambrel, with a hard hand again: then changing hand, and laying his right-arm over his back, he joins his right ſide to the left of the horſe, and curries him gently from the top of his withers to the lower part of his ſhoulder, every now and then fetching his ſtroke over the left ſide of his breaſt, and ſo currying him down to the knee, but no further; then he curries him all under his belly near his fore-bowels; and, in a word, very well over, except his legs under the knees, and his cambrels.

If your horſe, while you are currying him, keeps riggling up and down, biting the rack-ſtaffs, and now and then offering to ſnap at you, or lifting up his leg to ſtrike you, it is a ſign that he is not pleaſed, either by reaſon of the ſharpneſs of the comb, the teeth whereof muſt on that occaſion be blunted; or through wantonneſs, and the pleaſure he takes in the friction; then he muſt be gently corrected with the whip.

As this currying is only to raiſe the duſt, when it is over, the groom muſt take either a horſe's tail, or a clean duſting-cloth, and with it ſtrike off the looſe duſt raiſed by his comb: then dreſs him all over with the *French* bruſh, both head, body, and legs, to the very fetlocks, obſerving ways to clean the bruſh from the filth it gathers from the bottom of the hair, by the rubbing it on the curry-comb; and duſting the horſe a ſecond time. Which done, he dips his hand in water, and with it rubs his horſe's body all over, leaving if poſſible no looſe hair behind him; and with the ſame wet hand picking and cleaning his eyes, ears, noſtrils, ſheath, cods, and tuel; rubbing thus till he be as dry as he was at firſt; then he rubs his body all over with a hair-patch, but eſpecially his fore-bowels under his belly, his flank, and between his hind thighs; and laſtly, wiping him over with a fine white linen rubber.

When he has thus dreſſed him, he takes a large ſaddle-cloth, that may reach down to the ſpurring-place, and laps it about his body, then claps on his ſaddle, and throws a cloth over him for fear of his catching cold. Which done, he rubs and chafes his legs from the knees and cambrels downwards to the ground, with two ropes of ſtraw twiſted hard together, picking his fetlock-joints from duſt, filth, and ſcabs; rubbing and dreſſing his legs afterwards with another hair-patch.

This done, his feet muſt be picked clean with an iron picker, to hinder them from taking up ſtones, and his mane and tail combed down with a wet mane-comb; and having ſpirted ſome beer or wine into his mouth, and brought him out of the ſtable, the groom ſhould mount him, in order to take or walk him to ſome running river, or freſh clear ſpring, a mile or two diſtant from the ſtable, where he is ſuffered to drink half his draught at firſt, bringing him afterwards calmly out of the water, and riding him gently for awhile; for thruſting him then into a ſwift gallop, not only hazards the breaking of his wind, but endangers the uncording or burſting him, begets in him an ill habit of running away as ſoon as he has done drinking; and the foreſight he has of ſuch violent exerciſe, makes him often refuſe to quench his thirſt. When he has walked gently a little way, he may be put into a gentle gallop, for five or ſix ſcore, then take wind. And after he has been raked a pretty ſpace, the rider ſhews him the water again, and lets him drink as much as he pleaſes, and then gallops him again; proceeding

thus

thus till he will drink no more, avoiding above all things, to gallop him ſo much as either to chafe or ſweat him.

In galloping your horſe after water, it is not improper to give him ſometimes a watering courſe ſharply, or twelve or twenty ſcore, for then it will quicken his ſpirits, cauſe him to gallop more pleaſantly, teach him to manage his limbs, and ſtretch forth his body more largely.

When your horſe has done drinking, air him a foot-pace an hour, ſo long as you'll think ſufficient for the ſtate of his body, and afterwards ride him home.

Airing brings ſeveral advantages to the horſe; firſt, it purifies the blood, purges the body from many groſs and ſuffocating humours, and ſo hardens and enſeams the horſe's fat, that it is not ſo liable to be diſſolved by ordinary exerciſe. Secondly, it teaches him how to let his wind rake equally, and keep time with the other actions, or motions of his body. Thirdly, it ſharpens the appetite, and provokes the ſtomach; which is of great advantage both to hunters and galloppers, which are apt to loſe their ſtomach through exceſs or want of exerciſe: For the ſharpneſs of the air will drive the horſe's natural heat, from the exterior to the interior parts, which heat, by helping the digeſtion creates an appetite. Laſtly, it encreaſes luſt and courage in him, provided he be not too early aired; though Mr. *Markham*'s directions are different on this article; for he will have a horſe aired before ſun riſing, and after ſun-ſetting; and the gentleman's jockey ſays, that nothing is wholſomer than early and late airing, but experience proves the contrary; for in this art all things that any ways weaken nature, or hinder it from growing ſtrong and courageous, are to be avoided; ſuch as cold, which is always greater early in the morning, and in the evening, than it is in the other parts of the day; which is evidently apparent in horſes that run abroad all the winter, which however hardy bred, and kept with the beſt care and food, yet cannot by any means be advanced to ſo good caſe in winter, as an indifferent paſture will raiſe them to in ſummer. And this holding true of the nocturnal cold, muſt needs be verified in ſome meaſure of the morning and evening dew. Beſides, that the dews, and moiſt rimes, do as much injury to a horſe, as the ſharpeſt colds or froſts; ſince a horſe any ways inclinable to catarrhs, rheums, or any other cold diſtempers, is apt to have the humours augmented, and the diſeaſe muſt ſenſibly increaſe by the early and late airings. But if he be not brought forth to air, till the ſun be riſen, his ſpirits will be cheared up and comforted. Horſes, beſides naturally deſiring to enjoy the ſun's warmth, as well as almoſt all other creatures. Beſides the benefit of the ſun, the air is ſo mild and temperate, that it rather invigorates than preys upon his ſpirits; and rather increaſes his ſtrength, than impairs it.

During the time of your horſe's airing, you will eaſily perceive ſeveral marks of his ſatisfaction, and the pleaſure he takes in this exerciſe: For he will gape, yawn, and as it were ſhrug his body. If he offers to ſtand ſtill to dung or ſtartle, which his airing will provoke, you muſt give him leave, as likewiſe to ſtare about, neigh, or liſten to any noiſe.

When the groom is returned from airing, and diſmounted, he muſt lead his horſe on the ſtraw, which ſhould always lie before the ſtable-door; and there, by whiſtling, and ſtirring up the litter under his belly, will provoke him to ſtale, which a little practice will bring him to, and is advantageous for the horſe's health, and the keeping the ſtable clean; then leading him into his ſtall (which ſhould likewiſe be well littered) and having tied up his head to the empty rack, he takes off his ſaddle, rubs his body all over with the *French* bruſh, then with the hair-patch, and laſtly with the woollen cloth. This done, he cloaths him with a linen cloth next to his body, and over that a canvaſs cloth, both made ſo fit as to cover his breaſt, and to come pretty low down to his legs; which is the *Turkiſh* way of cloathing. Over theſe he muſt put a body cloth, of ſix or eight ſtraps, which is better than a ſurcingle, and pad ſtuffed with wiſps, to keep his belly in ſhape.

Both the temperature of the climate, and the ſtate of the body, are to be conſidered in the cloathing of a horſe; and that all horſes are not to be cloathed alike; for the *Barb*, *Turkiſh*, *Spaniſh*, &c. required more cloathing than the *Engliſh* common horſes, that are bred in a colder climate, and have naturally thicker ſkins and a longer coat. But however, take this for a general rule, that a rough coat ſhews want of cloaths, and a ſmooth one cloathing ſufficient; obſerving, that if by the countenance of your horſe, his dung, and other outward marks, he is known to be in health, notwithſtanding which his coat ſtares ſtill, you muſt add ſtill more till it lies flat; as on the other hand, if it will lie with the aſſiſtance of a ſingle linen cloth, he wants no other. But if after your horſe has been in keeping ſome time, you find him apt to ſweat in the night, it is a ſign that he is over fed and wants exerciſe: And if he ſweats at his firſt coming from graſs, the cloathing allotted at his firſt houſing muſt rather be increaſed than diminiſhed; for that ſweating proceeds from the

foul humours which oppreſs nature; and when by exerciſe they are evacuated, nature will ceaſe working, and he will continue in a temperate ſtate of body all the year after.

The horſe cloathed, his feet muſt be picked with the iron picker, and his hoofs waſhed clean, with a ſponge dipped in fair water, and then dried with ſtraw, or a linen cloth, waſhing, likewiſe, his legs, if dirty, provided they be rubbed dry afterwards. Then the horſe is left on his ſnaffle for an hour or more, to ſharpen his appetite. The hour expired, the groom returns to the ſtable, and taking a handful of hay, let his horſe taſte it out of his hand, till he has eaten it; then he pulls off his bridle, and having rubbed his head and neck clean with a cloth as before, he pulls his ears, and, ſtops his noſtrils, to make him ſnore, which will help to bring away the moiſt humours which oppreſs his brain; and then put on his collar, and give him a quartern of oats well ſifted. While he is eating his corn, his cloaths muſt be turned up, his fillets, buttocks, and gaſcoins rubbed over with the hair-patch; and after that with a woollen cloth. Then a clean flannel fillet-cloth is ſpread over his fillets and buttocks, to make his coat lie ſmooth, and his houſing-cloth turn'd down upon it; anointing his hoofs round, from the cornet to the toe, with an ointment made for the purpoſe; picking his feet with an iron picker, and covering them with cow-dung; by which time (if he be not a very ſlow feeder) he will have eaten his oats, which if he does with a good appetite, he muſt have another quart; feeding him thus by little and little, whilſt he eats with an appetite; but if he fumbles with his corn, he muſt have no more.

This done, a ſufficient quantity of hay, well duſted, muſt be thrown down to him on his litter, and then ſhutting up the windows and ſtable-door, he is left till one o'clock in the afternoon, at which time the groom returns to him, and having rubbed over his head, neck, fillets, buttocks, and legs, as before, with the hair-patch, and woollen cloth, he'll feed him as before, leaving him afterwards till the time of his evening watering, which ſhould be about three in the winter, and four in the ſummer; when he'll come to him, dreſs and ſaddle him as before, and having mounted him, ſhall take him to the water, and after drinking, and galloping, ſhall air him along by the river ſide, till he thinks it time to go home; then order him in all points, as to rubbing, feeding, ſtopping his feet, &c. as he did in the morning; and having fed him at ſix, he muſt feed him again about nine; littering him then well, and throwing him hay enough to ſerve him all night, and leaving him till the next morning.

This exerciſe of a groom muſt be repeated every day, and in the very ſame manner: Though as to that of feeding him, he muſt ſharpen his ſtomach by change of meat; giving him one meal clean oats; another oats and ſplit beans; and when he has brought him to eat bread, he may give another meal of bread, always obſerving to give him oftneſt what he likes beſt. Some horſes are of ſo hot a conſtitution, that without they may drink at every bit, they cannot eat, and thoſe horſes uſually carry no belly; in this caſe, a pale of water muſt ſtand continually before them, or at leaſt, water muſt be offered them at noon, beſides what they fetch abroad at their ordinary time. The habit of the body of a horſe, is alſo diſcovered by his digeſtion; whether he retains his food long, which is the ſign of a bad digeſtion; or whether nature expels the dung oftener, which if it does, and his dung be looſe and bright, it is a ſign of a good habit of body; but if he dungs hard and ſeldom, it is, on the contrary, a ſign of a dry body; and therefore, to remedy this a handful or two of oats, well waſhed in ale, ought to be given him once a day, whereby his body will be looſen'd and kept moiſt, ſerving likewiſe to expel winds.

During this fortnight's keeping, you are to make ſeveral obſervations, as to the nature and diſpoſitions of your horſe, temper of his body, *&c.* and order him accordingly. 1. If he be of a churliſh diſpoſition, you muſt reclaim him by ſeverity: if of a loving temper, win him by kindneſs. 2. You muſt obſerve whether he be a foul feeder, or of a nice ſtomach; if he be quick at his meat, and retain a good ſtomach, then four times of full feeding in the ſpace of a day and night, is ſufficient; but if he be a ſlender feeder, and ſlow at his meat, then you muſt give but little at once, and often, as about every two hours; for freſh meat will draw on his appetite; leaving always a little meat in his locker, for him to eat at his own leiſure, and when you find any leſt, you muſt ſweep it away, give him freſh, and expoſe that to the ſun and air, which will prevent its growing muſty, and reſtore it to its former ſweetneſs.

By that time the firſt fortnight is expir'd, the *hunter* will be in a pretty good ſtate of body, and fit for a moderate *hunting match*; but how to proceed in this exerciſe, meets with ſome difficulties; for ſome would have a horſe which is deſigned either for a *buck-hunter* or *fox-hunter*, uſed from the beginning to the chace they are deſigned for. Others think thoſe chaces too violent for a young horſe, and therefore chuſe to train him for harriers; which laſt opinion, ſeems to be founded on experience; and which may be confirmed by taking a

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ſlight view of the ſeveral chaces the moſt in vogue here in *England*, viz. the *ſtag*, *buck*, *hind*, *fox*, *otter*, and *hare*.

There is very little difference in the three fore-mentioned chaces, and the inconveniences of each of them are, in a manner, the ſame; for they are all, either in covert, or at force. Now if *deer* be hunted in a park, they uſually chuſe the moſt woody part of it, as a refuge from the purſuit of their enemies, which is both unpleaſant to the rider, and troubleſome to the horſe to follow the dogs through the thick buſhes; and beſides, the ground in parks is uſually full of mole-banks, trenches, *&c.* which is dangerous for a young horſe to gallop on, till he has attained to ſome perfection in his ſtroke. But if they be turned out of the park, and be hunted at force, you'll find that as ſoon as you have unharboured, or rouzed them, they will immediately make out endways, before the hounds, five or ſix, nay ſometimes ten miles, they following in full cry ſo ſwiftly, that a horſe muſt be compelled to run up and down hill without any intermiſſion; leaping hedge, ditch, and dale, nay often croſſing rivers, to the great danger of the rider, as well as of the horſe. So that it is altogether improper to put a young horſe to ſuch violent labour at firſt, till by practice and degrees he has been made acquainted with hard ſervice. Beſides the ſwiftneſs and violence of this chace, the danger of cracking his wind, and burſting his belly, of ſtraining his limbs, and of creating in a young horſe a loathſomeneſs to his labour; the ſeaſon for theſe chaces beginning about *Midſummer*, and ending about *Holy-Rood-Tide*, during which the heat of the ſun is exceſſive, and ſo ſcorches the earth, a violent chace would hazard the melting his greaſe; and the weight of the rider, by reaſon of the hardneſs of the ground, would occaſion foundering, ſplints, and wind-galls, inſomuch that in a ſhort time, the horſe would prove altogether uſeleſs.

However there is not the ſame danger for all ſorts of horſes, without diſtinction; but none ſhould be employed in this chace but thoſe of ſtayed years, which by long practice and experience, have been trained to hunting. Young horſes (as the Duke of *Newcaſtle* obſerves) being as ſubject to diſeaſes, as young children, and therefore he adviſes any man who would buy a horſe for his uſe, either for a journey, hawking, and hunting, never to buy him, till the mark be out of his mouth; for if he be ſound of wind, limb, and ſight, he will laſt eight or nine years with good keeping, and never fails his rider. An old nag, in his Grace's opinion, of ſome huntſman, or falconer, that is ſound, is the beſt; for he gallops on all grounds, leaps over hedges and ditches, and never fails his rider in a journey, nor any where elſe.

Fox-hunting is not at all proper for the training of a young horſe, ſince it is ſwift without reſpite, and of long continuance, both which are diſtaſteful to him. When a fox is unkennelled, he ſeldom or never betakes himſelf to a champaign country, but remains in the ſtrongeſt coverts, and in the thickeſt woods; ſo that a horſe can but ſeldom enjoy the pleaſure of accompanying the hounds, without hazarding being ſtubbed, or other accidents equally dangerous. The fitteſt horſes for this chaſe, are horſes of ſtrength and hability; ſince it begins at *Chriſtmas*, which is the worſt time for riding, and ends at *Lady-Day*, when the ground is fitteſt for it.

Neither is the chace of the *Otters* convenient for a horſe; for he that will truly purſue this *amphibious ſport*, muſt often ſwim his horſe, which cannot be done without running ſome danger.

The chace of the *Hare* is not ſo contrary to the training of young horſes; becauſe hares, commonly running the champaign country, and their ſcent being not ſo hot as that of the *Foxes*, the dogs are oftener at default, the horſe has by that means many ſobs, whereby he recovers wind, and regains new ſtrength.

The beſt dogs to bring your horſe to perfection of wind and ſpeed, are the fleet northern hounds; for they, by means of their hard running, will draw him up to that extraordinary ſpeed, that he will not have time to loiter; and by continual practice will be ſo inured, and uſed to the violence of their ſpeed, that, in a ſhort time, he will be able to ride on all ſorts of ground, and be of ſuch command upon the hand, that he will ſtrike at what rate you pleaſe, and three quarters ſpeed will be leſs troubleſome to him, than a *Canterbury* gallop.

The day being fixed for your horſe's firſt going abroad after the dogs; the preceding day he muſt be ordered after this manner. In the morning proceed in your uſual manner, as to dreſſing, feeding, watering, *&c.* only abſtaining that day from giving him beans, becauſe they are hard of digeſtion, inſtead of which you'll give him moſt bread, if he can eat it, becauſe more nouriſhing than oats; and after the evening watering, which ought to be ſomewhat earlier than at other times, give him only a little hay out of your hand, and no more till the next day, at his return from hunting; and to prevent his eating his litter, or any thing elſe, but what you give him, you muſt, inſtead of a muzzle,

muzzle, put on a cavezone, join'd to a head-ſtall of a bridle, being lined with double leather for fear of hurting him, and tying it ſo ſtrait as to hinder his eating; and this will prevent ſickneſs in your horſe, incident to ſome horſes, when their muzzle is ſet on, notwithſtanding the invention of the lattice window, at preſent ſo much in uſe; but this way your horſe's noſtrils are at full liberty, and he will never prove ſick. But as to his corn, give him his meals, both after his watering, and at nine o'clock; at which time he ought to be littered very well, that he may the better take his reſt, and leave him for that time.

About four o'clock the next morning, he muſt have a quarter of a peck of clean oats, mixed with a quart of ſtrong ale, and while he is eating it, his litter and dung muſt be put back, and the ſtable cleanſed. When he has done eating, he muſt be bridled and dreſſed; when dreſſed, ſaddle him, throwing afterwards his cloaths over him, and letting him ſtand till the hounds be ready to go forth, forbearing the drawing the ſaddle girt ſtrait, till you are ready to mount, leſt otherwiſe he ſhould grow ſick. But generally old horſes are ſo crafty, that when an ignorant groom goes to gird them up hard, they will ſtretch out their body to ſuch a bigneſs, by holding up their wind (on purpoſe to gain eaſe after they are girt) that it will appear difficult to girt them; but afterwards they let go their wind, and their body falls again.

When the hounds are unkennelled (which ought not to be till ſun-riſing) you muſt go up and down the field along with them, and rake your horſe up and down gently till a hare be ſtarted, always obſerving to let him ſmell at other horſes dung (if he wants to do it) which will provoke him to empty himſelf, and let him ſtand ſtill while he does it. And if you meet with any dead frog, ruſhes, or the like, ride him upon them, and by whiſtling provoke him to empty his bladder.

When the hare is ſtarted, you are to follow the hounds as the other hunters do, only obſerving that this being the firſt time of your horſe's hunting, he is not ſo well acquainted with the different ſorts of ground, as to know how to gallop ſmoothly and with eaſe on them: Therefore you are not to put him as yet to above half his ſpeed, that he may learn to carry a ſtaid body, and to manage his legs both as to fallow, and greenſod; neither are you to gallop him often, nor any long time together, for fear of diſcouraging him, and breeding in him a diſlike to the ſport; but obſerving to croſs the field ſtill to your beſt advantage, you ſhall make into the hounds at every default, and ſtill keep your horſe as much as poſſible within the cry of the dogs, that he may be uſed to it, and you'll find that in a very ſhort time he'll take ſuch delight and pleaſure in it as to be eager to follow them. If at any time the chace be led over a carpet-ground, or ſandy highway, on which your horſe may lay out his body ſmoothly, you may there gallop him for a quarter or half a mile, to teach him to lay out his body and to gather up his legs, to enlargen and ſhorten his ſtroke, according to the different earths he gallops on, as if on a green, ſwarth, meadow, moor, heath, *&c.* then to ſtoop and run more on the ſhoulders: if among mole-hills, or over high ridges and furrows, then to gallop more roundly, and in leſs compaſs, or according to the vulgar phraſe, two up and two down, that thereby he may ſtrike his furrow clear, and avoid ſetting his fore feet in the bottom of it, and by that means fall over; but by this way of galloping, though he ſhould happen to ſet his feet in a furrow, yet carrying his body ſo round, and reſting on the hand in his gallop, would prevent his falling; and nothing but uſe and ſuch moderate exerciſe can bring him to his perfection.

About three o'clock in the afternoon you muſt have your horſe home in a foot pace, as you came out in the morning, but he ſhould be cool before he comes out of the field, and if he has not ſweated a little you muſt gallop him gently on ſome ſkelping earth, till he ſweats at the root of his ears, a little on his neck, and in his flank, which muſt be done of his own voluntary motion, without the compulſion of whip and ſpur; and then when he is cool, have him home and ſtable him, avoiding walking him in hand to cool him, leſt he ſhould cool too faſt.

When ſet in his ſtall, which ſhould be well littered againſt his coming home, his head muſt be tied up to the ring, with the bridle, rubbing him well afterwards with dry ſtraw, both head, neck, fore-bowels, belly, flank, buttocks, and legs, and then his body over with a dry cloth, till there be not a wet hair left about him. This done, his ſaddle is taken off, and the place where the ſaddle ſtood rubbed dry, cloathing him immediately after with his ordinary cloaths leſt he ſhould catch cold, unleſs he be too hot, for then a ſpare cloth muſt be thrown over him for fear he ſhould cool too faſt; and leaving him afterwards to ſtand on his ſnaffle two hours or more, ſtirring him now and then with the whip, in his ſtall, to keep his legs and joints from growing ſtiff.

When thoroughly cold he muſt be unbridled, have his head rubbed, and his feet picked from dirt and gravel, which he may have gathered abroad; and then his collar is put on, and a quart,

or

or three pints of oats mixed with a handful of clean dusted hempseed given him: after which the spare cloth is removed for fear of keeping him hot too long; and when he has eaten his corn, he must be left to rest two or three hours, with a sufficient quantity of clean hay before him.

Whilst you are absent from him, you shall prepare him a good mash, made of half a peck of malt well ground, and boiling-hot water, observing to put no more water than your malt will sweeten, and your horse will drink, and having stirred them together with a stick, you'll cover it over with a cloth, till the water has extracted the strength of the malt. Then when it is cold, that you can scarce perceive it to smoak, offer it to your horse, and when he has drank the water, let him, if he will, eat the malt also; but if he refuses to drink, yet you must give him no other water that night, but by placing it in one corner at the head of the stall, in such a manner that he may not throw it down, let him stand by it all night that he may drink at his pleasure.

When he has eaten his mash, strip him of his cloaths, and run him over with your curry-comb, *French* brush, hair-patch, and woollen cloth, and cloath him up again, cleaning his legs as well as his body of all dirt and filth; then remove him into another stall, and bathe his legs all over from the knees, with a quart of warm urine, in which four ounces of salt-petre have been dissolved; then having rubbed his legs dry, set him into his stall, and give him a good home-feeding of oats, or bread, or both, and having shook a good deal of litter under him, that he may rest the better, and thrown him hay enough for all night, shut up your stable close, and leave him to his rest till morning; at which time you must come to him betwixt six and seven o'clock. If he be laid, disturb him not, but stay till he rises of his own accord; but if he be risen then go to him, and begin by putting back his dung from his litter, then proceed to order him as in his days of rest, *i. e.* to give him a handful or two of oats before water, then to dress, water, air, feed, *&c.*

The next day after he has rested you shall hunt him again; hunting him thus three times a week, for a fortnight together, observing to give him his full feeding, and no other scowring but mashes and hempseed, which is equal in virtue to any other, and only carries off superfluous humours.

By this time your horse will be drawn so clean, his flesh will be so unseamed, and his wind so improved, that he will be able to ride a chace of three or four miles without much blowing or sweating, and you'll find by his chaul and flank, as well as by his ribs, that he is in an indifferent state of body; and therefore, the next fortnight following, you must increase his labour, by which means you will come to a true knowledge of what he is able to do; and whether or no he will ever be fit for plates, or a match.

When your horse is set over night, and fed early in the morning, then go into the field with him, and when he is empty, as he will be by that time you have started your game, you shall follow the dogs at a good round rate, as at half speed, and so continue till you have killed or lost your first hare. This will so rack your horse's mind, and by this time he will have so emptied himself, that he will be fit to be rid the next chace briskly: which as soon as begun, you shall follow the dogs, at three quarters speed, as near to them as is consistent with the discretion of a good *horseman*, and a true huntsman, who will always take care not to strain him.

During this day's riding you'll observe your horse's sweat under his saddle and fore-bowels; if it appears white like froth or soap-suds, it is a sign of inward glut and foulness, and that your day's sport was fully sufficient, and therefore you must have him home, and order him as before directed.

When you unbridle your horse, give him instead of hempseed and oats, a handsome quantity of rye-bread, which being cold and moist, will assist in cooling his body after his labour, and prevent costiveness, to which you'll find him addicted; then give him hay, and afterwards a mash, and afterwards order him in all points as formerly.

The day following you may hunt your horse again, but not so severely as you did the day before, till the afternoon; then ride him after the hounds briskly, and if that does not make him sweat thoroughly, make another train-scent, and follow the dogs three quarters speed that he may sweat heartily. When you have a little cooled him, have him home, and upon his first entrance into the stable, give him two or three balls as big as walnuts of the following scowring.

Take butter four ounces, lenitive electuary two ounces, granwel-broom and parsley-seeds, of each one ounce, jalap an ounce; put the seeds into powder, and stir them into a paste, with the electuary and the butter, knead it well, and keep it close in a pot for use.

As soon as you have given your horse these balls, rub him dry, then dress him, and cloath him up warm, and let him stand two or three hours on the snaffle; then give him two or three handfuls of rye-bread, and order him as you did before, as to hay, provender, mash, *&c.* and so leave him till the morning. Then come to him, and first observe his dung, whether it keeps the true colour, or whether it appears dark or black, or red and high-

high colour; next, whether it be looſe and thin, or hard and dry. If it be of the right colour, I mean of pale yellow, it is a ſign of health, ſtrength, and cleanneſs; if it be dark or black, then it is a ſign there is greaſe and other ill humours ſtirred up, which are not yet evacuated; if it be red and high coloured, then it is a token that his blood is feveriſh and diſtempered through inward heat; if it be looſe and thin it is a ſign of weakneſs; if hard and dry, it ſhews the horſe to be hot inwardly, or elſe that he is a foul feeder; but if his dung carries a medium betwixt hard and ſoft, and ſmell ſtrong, it is a ſign of health and vigour.

Theſe obſervations made with regard to his dung, he muſt be fed, dreſſed, watered, *&c.* as in his former days of reſt; obſerving always to give variety, and his belly full of corn and bread. Next, have him abroad in the fields again, but by no means put him to any labour further than to take him from hill to hill after the dogs, to keep him within ſound of their cry; for the deſign of this day's exerciſe is only to keep him in breath, and get him an appetite. Obſerve as you ride that you let him ſtand ſtill to dung. When the day is near ſpent, bring him home without the leaſt ſweat, and order him as at other times, abſtaining only from giving him ſcowrings, or rye-bread. You may, if you will, water your horſe this day, both at your going into the field, and at your coming home, obſerving to gallop after it, to warm the water in his belly.—The next is a day of reſt.

To order a *horſe* for a *match* or a *plate*, there are ſeveral other neceſſary rules to be obſerved.

Firſt, keep him for a whole month carefully, and without any violent exerciſe, in order to draw his body perfectly clean, and to refine his wind to that degree of perfection it can attain to; which to accompliſh, we muſt obſerve whether our horſe be low or high in fleſh, or whether he be dull and heavy when abroad, and this occaſioned through too much hard riding, or through ſome greaſe that has been diſſolved by hunting, and has not been removed for want of a ſcowering. If he appears ſluggiſh and melancholy from either of theſe cauſes, we muſt give him half an ounce of *diapente* in a pint of good old *Malaga* ſack, which will both cleanſe his body and revive his ſpirits; and then feed him for the firſt week continually with bread, oats, and ſplit beans, giving him ſometimes one and ſometimes the other, according as he likes, always leaving ſome in his locker, to eat at his own leiſure; obſerving at the ſame time, that the oats muſt have been well dried in the ſun, and afterwards hulled, before they are given our horſe: that the beans muſt alſo be hulled, and that he muſt have none but the crumb of the bread, becauſe the crufl is hard of digeſtion, and apt to dry and heat his body. This bread muſt be made of an equal quantity of beans and wheat, kneaded with new ale-barm, and the whites of new-laid eggs. Thus a horſe is to be fed till we have made him wanton and gameſome.

But if on the contrary the horſe be briſk and lively, we muſt abſtain from giving him any ſort of ſcowring whatſoever; for there being no foul humours, or any other ſuperfluous matter left in his body for the phyſick to work upon, it will prey upon the ſtrength of his body, and by that means weaken it.

He ſhould be kept near the place where he is to run, that he may be acquainted with the ground; regulating the number of heats according to the articles ſtipulated for the match, and the ſharpneſs of them according to the temper of his ſtrength, and the purity of his wind; providing when we heat him, ſome horſes upon the courſe to run at him, which will quicken his ſpirits, and encourage him, when he finds he can command them at his pleaſure, abſtaining always from giving our horſe a bloody heat for ten days, or a fortnight before the day the plate is to be run for; giving him his laſt heat before the day of trial in all his cloaths, only ſkelping it over, which will make him run the next time much more vigorouſly, when he ſhall be ſtript naked, and feel the cold air pierce him.

During this month, both on his reſting days, and after his ſweats on heating days, we are to obſerve the ſame rules taught in the firſt week of our third fortnight's keeping, omitting only all ſcowrings but rye-bread and maſhes, ſince our horſe be in ſo perfect a ſtate of body as not to need any; only if we think there may be any occaſion, and our horſe proves thirſty, we may give him about eight or nine o'clock at night, to cool him, and quench his thirſt, two quarts of barley water, mixed with three ounces of ſyrup of violets, and two ounces of ſyrup of lemons. If he refuſes this mixture, it muſt be left to ſtand by him all night.

During the laſt fortnight, his oats muſt not only be dried and hulled, but likewiſe half a ſtrike of it ſhould be waſhed in the whites of a dozen or twenty eggs, which muſt be left to ſoak ſpreading them in the ſun, the next morning, till they be as dry as they were at firſt, and then be given to the horſe to ſtrengthen his wind.

If he will eat his oats without beans, there is no neceſſity to give him any: and this fortnight his bread ought to be three parts wheat to one of beans. If he be inclined to be coſtive, we muſt relieve nature, by giving him oats waſhed in two or three whites of eggs, and all beat together.

During the laſt week, inſtead of a maſh, he ſhould have the barley-water; giving him hay, as much as he will eat, till a day before he is to ride

his

his match, when we muſt be pretty ſparing of it, that he may have time to digeſt that he has eaten, muzzling him then with our cavezone; and feeding him that day, till the next morning he is led out, as much as poſſible. That morning, an hour before we are to lead out, we'll give him a toaſt or two of white bread ſteeped in ſack, and ſo lead him into the field.

But if we are to run for a plate, which uſually is not till three o'clock in the afternoon, our horſe muſt be had out early in the morning to air, that he may empty his body; and at his return from airing, we'll feed him with toaſts in ſack. When he has eaten what we think fit to give him, we put on his cavezone; then chafe his legs ſoundly with train oil, and brandy warmed together, ſhake up his litter, ſhut up our ſtable cloſe, and leave him to his reſt, till the hour of his going into the field.

The perſon who is to ride him, ſhould always be the ſame that has trained him, and the firſt thing requiſite in a *rider*, next to the faithfulneſs in his truſt, is to have a good cloſe ſeat, keeping his knees firm to his ſaddle ſkirts, his toes turn'd in ward, and his ſpurs outward from the horſe's ſides; his left-hand governing his mouth, and his right commanding his whip, taking care throughout the whole trial, to ſit firm on his ſaddle, without waving, or ſtanding up in his ſtirrups, which very much incommodes the horſe. When he ſpurs his horſe, he muſt not ſtrike him hard with the calf of his leg, as if he would beat the wind out of his body, but juſt turn his toes outwards, and bring the ſpurs quick to his ſides; and ſuch a ſharp ſtroke will be more ſerviceable to the quickening of his horſe, and ſooner draw blood, never ſpurring his horſe but when there is occaſion, and avoiding ſpurring him under the fore-bowels, between his ſhoulders and his girts, near the heart, till the laſt extremity. When he whips his horſe, it muſt be over the ſhoulder on the near ſide, except upon hard running; and when he is at all, then he muſt be ſtruck in the flank with a ſtrong jirk, for there the ſkin is tendereſt, and moſt ſenſible of the laſh. Taking care when he whips, or ſpurs his horſe, and he is certain that he is at the top of his ſpeed, if then he claps his ears on his pole, or whiſks his tail, to bear him hard, and to give him as much comfort as ever he can, by ſhaking his ſnaffle to and fro in his mouth, and by that means forcing him to open his mouth, which will comfort him, and give him wind.

If while he rides, there be any high wind ſtirring, and that wind be in his face, he muſt ſuffer his adverſary to lead and hold hard behind him, till he ſees his opportunity of giving a looſe; taking care, notwithſtanding, to ride ſo cloſe to him, that his horſe may break the wind from his own; and that he, by ſtooping low in his ſeat, may ſhelter himſelf under him, which will aſſiſt the ſtrength of his horſe. But if the wind be in his back, he muſt ride exactly behind his adverſary, that his horſe may alone enjoy the benefit of the wind, by being as it were blown forward.

He muſt obſerve next, what ground his horſe delights to run beſt on, bearing him, as much as his adverſary will give him leave, on level carpet-ground; becauſe his horſe naturally will be deſirous to ſpend himſelf more freely thereon. But on deep earth, *&c.* he muſt give him more liberty, becauſe he will naturally favour himſelf thereupon. In running up a hill, he ought to favour his horſe, and bear him for fear of running him out of wind; but down hill (if his horſe's feet and ſhoulders will endure it, and he dares venture his own neck) he muſt always give him a looſe. Taking this for a general rule, that if he finds his horſe to have the heels of the other, he be careful to preſerve his ſpeed till the laſt train-ſcent, if he is not to run a ſtrait courſe; but if he is, then till the courſe, and ſo huſband it then too, that he may be able to make a puſh for it at the laſt poſt.

He muſt next obſerve his oppoſite's horſe, and if he be fiery, run juſt behind, or juſt ſide by ſide, and with his whip make as much noiſe as he can, to force him on faſter than his rider would have him, and thereby ſpend him the ſooner. Or elſe keep juſt before him upon ſuch a ſlow gallop, that he may either over-reach, or by treading on his horſe's heels, endanger falling over. He ſhould likewiſe take notice on what ground the contrary horſe runs worſt, and on that ground give his a looſe, that the adverſary's being forc'd to follow, may hazard ſtumbling, or clapping on the back ſinews. Minding, beſides, in his riding, the correction of the hand, the whip and the ſpur of the oppoſite rider, and when, and how often he makes uſe of them; and when he perceives that his horſe begins to be blown, by any of the aforementioned ſymptoms, as whiſking his tail, clapping down his ears, holding out his noſe like a pig, *&c.* he muſt take it for granted that he is at the top of what he can do; therefore he ought to obſerve, in this caſe, how his own rides, and if he runs chearfully and ſtrongly without ſpurring, he ſhould keep his adverſary to the ſame ſpeed, without giving him eaſe, and by that means will ſoon bring him to give out, or diſtance him.

At the end of every train-ſcent, notice ſhould be taken of the condition the other horſe is in, and how he holds in his labour; which may be eaſily diſcovered by his looks, the working of his flank, and the ſlackneſs of his girts. For if he looks

dull, it is a ſign his ſpirits fail him, as well as his wind, if his flanks beat much, and conſequently his ſtrength. If his wind fails him, his body will grow thin, and appear tucked up, which will make his girts appear ſlack to the eye; which is the greateſt ſign of a horſe's weakneſs; and the ſureſt that he'll loſe the wager.

When each train-ſcent is ended, or after every heat for a plate; the groom muſt, with an old piece of a ſword blade (called by the Duke of *Newcaſtle*, a *knife of heat*) ſcrape off all the ſweat from the horſe's neck, body, *&c.* rubbing him afterwards all over, firſt with ſtraw, and then with dry cloaths, both linen and woollen (which have been ſteeped in urine and ſalt-petre a day or two, and then dried in the ſun) while others are employed about his legs; which after they have been rubbed dry, muſt be chafed with wet cloaths, ſteeped likewiſe in urine and ſalt-petre, never giving over till the horſes are called by the judges to ſtart again.

The next thing to be conſidered, is the office of the *judges* or *triers*, which is to ſee that all things are ordered according to the articles, which to that end, are to be publickly read before the horſes ſtart.

Therefore each *trier*, on whoſe ſide the train is to be led, according to the articles, gives direction for its leading, according to the advice of the rider, or his knowledge of the nature and diſpoſition of that horſe on whoſe ſide he is choſe.—Each trier ought to be ſo advantageouſly mounted, as to ride up behind the horſes all day; and to obſerve that the oppoſite horſe rides his true ground, and keeps to the articles in every point, or elſe not permit him to proceed.—After each train-ſcent is ended, each trier is to look to that horſe, againſt whom he is choſen, and take care that he be no ways relieved but with rubbing, except liberty on both ſides be given to the contrary. As ſoon as the time allowed for rubbing is expired, which is generally half an hour, they ſhall command the riders to mount, and if either rider refuſes, it may be lawful for the other to ſtart without him, and having beat him the diſtance agreed on, the wager is to be adjudged on his ſide.

The triers muſt keep off all other horſes from croſſing the riders, or leading them; only they themſelves may be allowed to inſtruct the riders by word of mouth how to ride, whether ſlow or faſt, according to the advantages he perceives may be gain'd by his directions. If there be any weight agreed on, they ſhall ſee that both horſes bring their true weight to the ſtarting place, and carry it to the end of the train, on penalty of loſing the wager.—The ſame rules are to be obſerved, eſpecially this laſt, by thoſe who are choſen to be judges at a race for a plate; only they uſually ſtay in the ſtand, that they may the better ſee which horſe wins the heat.

If you know your horſe to be tough at bottom, and that he will ſtick at mark, to ride him each heat, according to the beſt of his performance, and avoid as much as poſſible either riding at any particular horſe, or ſtaying for any, but to ride each heat throughout with the beſt ſpeed you can. But if you have a fiery horſe to manage, or one that is hard-mouth'd, and difficult to be held, then ſtart behind the reſt of the horſes, with all the coolneſs and gentleneſs imaginable; and when you find your horſe to begin to ride at ſome command, then put up to the other horſes, and if you find they ride at their eaſe, and are hard held, then endeavour to draw them on faſter; but if you find their wind begins to rake hot, and that they want a ſob, if your own horſe be in wind, and you have a looſe in your hand, keep them up to their ſpeed, till you come within three quarters of a mile of the end of the heat; and then give a looſe and a puſh for it, and leave to fortune, and your horſe's goodneſs, the event of your ſucceſs. Avoiding all foul play, as croſſing, hanging on the poſts, leaning on the other horſeman, yoking, *&c.* which are to be abhorred by all honeſt horſemen.

When your trial for the plate is ended, as ſoon as you have rubbed your horſe dry, you muſt cloath him up, and ride him home, where you muſt give him firſt, a pint and a half of ſweet milk, with three yolks of eggs beaten into it, which muſt be made lukewarm, adding to it afterwards, three-penny worth of ſaffron, and three ſpoonfuls of ſallad oil; which mixture ought to be given him in a horn.

This done, dreſs him ſlightly over with your curry-comb, bruſh, and woollen cloth; and then bathe the place where the ſaddle ſtood with warm ſack, to prevent warbles, and waſh the ſpurring places with piſs and ſalt, anointing them afterwards with turpentine, and powder of jet mixed together, littering well the ſtable, and then cloathing him up quickly. And after he has ſtood for two hours, he muſt be fed with rye-bread, after that with a very good maſh; then giving him his belly full of hay, and what corn and bread he'll eat. And laſtly, bathing his legs well with urine and ſalt-petre, leaving corn in his locker, without diſturbing him any more till next morning.

Horſes employed in other ſervices, as in the army, coach-horſes, pack-horſes, *&c.* need not ſo much care and attendance, and every groom knows how to dreſs them, feed them, *&c.* to keep them in a good ſtate of body, and render them thereby capable of doing the ſervice they are deſign'd for.

Horſes are ſubject to an infinite number of *diſeaſes*, or *infirmities*. The moſt dangerous are the FARCY, or FASHIONS. This diſeaſe in horſes is infectious, and ſpreads a true plague. It conſiſts in a corruption of the blood, which ſhews itſelf in eruptions of hard puſtules, knots or ſtrings along the veins, and in ulcers; occaſioned by over heats and colds, ſometimes by ſpur-galling with ruſty ſpurs, ſnaffle-bit, or the like; or by the bite of another horſe infected with it; or if in the leg, by cutting or interfering.

This diſeaſe is commonly divided into theſe kinds, *viz. button*, or *knotted farcy*, the *running farcy*, the *water farcy*, and the *pockey farcy*; which are all the ſame, only differing in degrees of malignity.

The beſt method of curing this diſeaſe is, by correcting and carrying off the humours the blood is vitiated with, in order to reſtore it to its priſtine ſtate, and this muſt be done ſoon; otherwiſe, if the *farcy* be too far gone, and has ſeized the horſe's lungs, or ſome other noble parts, it is not to be attempted with any great hope of ſucceſs.

The firſt remedy to be adminiſtered, in this caſe, is a purging maſh, to mitigate the venom, and carry off a great deal of theſe humours from the vital and noble parts; repeating the ſame remedy twice, thrice, or four times, at due intervals, *i. e.* as ſoon as his ſtrength will permit.—The following is an excellent purge for this purpoſe.

Take four ounces of aloes ſuccotrine, reduced into powder, and pour upon it half a pint of ſpring-water, wherein has been diſſolved, over a gentle fire, an ounce of *Spaniſh* liquorice juice; put them in an earthen pan, over a gentle fire, ſtirring it continually, that the aloes may not burn at the bottom, and till about half the water be evaporated. Which done, there muſt be added to it jalap, colocynthus, tartar, agarick, all in powder, of each half an ounce; mercurius dulcis half an ounce; and oil of anniſeed one drachm and a half, mixing well all together in a mortar, to be formed into balls. Of which one ounce, or ten drachms, is a doſe ſufficient to purge any horſe, or at moſt one ounce and a half.

After your horſe has done taking this purge, you muſt give him at a time, mixed in his oats and beans, three or four ounces of the following digeſtive powder.

Take one pound of antimony in powder, half a pound of *lignum vitæ* in powder, three ounces of cinnaber of antimony; powder of liquorice four ounces; powder of elecampane four ounces; anniſeed three ounces; all which muſt be mixed together, and kept in a bottle well cork'd for uſe.

While your horſe is under cure, he muſt drink no water without a quart, three pints, or more, of the following diet-drink, put in his pail adding to it as much cold water as you think he will drink at a time, and if he refuſes at firſt, let him be without water till he drinks it.

Take one pound of antimony in powder, one pound of quickſilver, grind them well together in an iron mortar for about three or four hours, then boil them in a new iron pot, being firſt tied up in a piece of cloth, with theſe following ingredients tied up in a rag likewiſe, *viz.* raſpings of guaiacum, three pounds; the bark of guaiacum bruiſed, two pounds; raiſins ſlit, one pound and a half; figs ſlit, one pound; carraway-ſeeds, half a pound; fennel-ſeeds, half a pound; liquoriſh cut and ſlit, half a pound; boil all theſe in eight or ten gallons of running water, till it be reduced to half; to which add three quarts of lime-water.

Laſtly, if you perceive that any of the knots or ſwellings are ripened, you muſt open them with a lancet to let out the corruption, and then waſh them with the following green water.

Take one ounce of verdigreaſe, one ounce and a half of roch allum, two ounces of copperas, one ounce and a half of Roman vitriol, all in powder; put them into a quart bottle, upon which pour one quart of the beſt and ſtrongeſt white-wine vinegar; put this bottle into a kettle full of water, on a rowl of hay, to hinder it from touching the bottom of the kettle, and make it ſtand upright, ſo that two or three inches of its neck may remain above the water: the bottle being corked, with a cork with two or three notches for vents leſt the bottle ſhould break, put the kettle over a fire, or let it boil till the vinegar has diſſolved the powders, helping to do it, by often ſhaking the bottle. When diſſolved, take the liquor from the fire, and keep it in a bottle well corked.—Half a pint or more of this vinegar is mixed with a quart of old chamber-lye, when one wants to uſe it.

Beſides the *knotted farcy*, which this green water cures effectually, it cures likewiſe, at once or twice dreſſing the *mellander*, the *rat tails*, *ſcratches*, *gourd* or *ſwell'd legs* and *heels*; it prevents and cures the greaſe fallen into the legs and heels, cleanſes and heals all ulcers and wounds, prevents the breeding of *worms* and *proud fleſh*, expelling beſides or driving away any flux of humours from any part; alſo *chifts* and *cracks* in the heels, pains, *&c.* preventing of wind-galls, *&c.* the green water alone, without the chamber-lye, is the beſt remedy to cure all fiſtula's, cankers, and galled backs.

Horſes are alſo ſubject to *colds*, *coughs*, &c. which

to cure, eſpecially *new cold*, *cough*, or *graſs cold*, the following pectoral drench is excellent.

Take one pound of raiſins of the ſun, two ounces of ſlic'd liquorice, two ounces of ſugar-candy, one pound of treacle, three ounces of ſallad-oil, three ounces of horſe ſpice, two or three heads of garlick pounded with raiſins, two ſpoonfuls of honey, and three quarts of ale; boil it till it be reduced to two quarts, and give about a pint of it in the morning, faſting one or two hours after it; and repeating it every morning as occaſion requires. Twice is enough for a cold, and the whole will do in moſt of the other caſes. — It is good for a *ſurfeit*, *ſhort winded*, *head bound*, and to make a lean horſe thrive.

As horſes are very ſubject to *ſwellings*, the following poultice is very good to diſſolve them.

Take of our garden green orris roots, and white lilly roots, of each an ounce, marſh mallows, pellitory, pennyroyal, origan, calamint, rue, of each a handful, camomile, melilot, and elder flowers, of each half a handful, green anniſeeds, common fennel and cuminſeeds, of each half an ounce; boil them to a maſh in water and white-wine vinegar, then bruiſe them into an even ſmooth maſh in a ſtone mortar, adding to them of the meal of lupins and of beans, of each one ounce and a half, an ounce and a half of oil of camomile, one ounce and a half of oil of orris; mix them well in the mortar, heating them again afterwards, and applying more or leſs of this poultice hot on the part affected.

But if the ſwelling cannot be diſſolved, they ought to be ripened as ſoon as poſſible, and the following poultice is very proper for that purpoſe.

Take white lilly, and marſh-mallow roots, of each four ounces; the leaves of common mallows, marſh-mallows, groundſel, violet plants, brank urſin, of every one a handful; the meal of lintſeed and fenugreek ſeeds, gooſe fat and oil of lillies, of each three ounces. The roots when waſhed and ſliced, are to be boiled in water, and the leaves being added ſome time after, the boiling is to be continued till the whole maſh becomes perfectly tender and ſoft; when having ſtrained the decoction, you'll beat the remaining groſs ſubſtance in a ſtone mortar with a wooden peſtle to a pulp; then let the decoction and pulp be put into a ſkillet, and having mixed the meals of lint-ſeeds and fenugreek ſeeds, gooſe fat and oil of lillies, let them boil together over a gentle fire, ſtirring the ingredients from time to time, till they all be ſufficiently thickened for a poukice.

Horſes being alſo very ſubject to worms, the following remedy is accounted very good to kill them.

Take half a pound of the beſt antimony in powder, and two ounces of quickſilver, boil them in four pales of water till they be reduced to three; of which mix half a pailful with as much water as your horſe will drink, having firſt ſtrained it, and continue thus till it is all gone.

It ſometimes happens that a horſe is bitten by a mad dog, which if not immediately remedied, may be attended with very dangerous conſequences; and which to perform with hopes of ſucceſs, all the bitten parts muſt be ſeared as ſoon as poſſible with a hot iron; with this caution, that you ſear not, nor let the hot iron touch either nerve or tendon, the eyes, or any member whereby the horſe may receive any damage from the operation; applying afterwards a ſtrong bliſtering plaiſter, as well to every part touched with the hot iron, as to thoſe which you could not attempt to ſear, though bitten likewiſe. — That bliſtering plaiſter muſt be compoſed in the following manner.

Take an ounce of *Burgundy* pitch, ſhip pitch, and common roſin, of each half an ounce; of the common *lapis infernalis*, or cauſtic ſtone, one drachm, cantharides or *Spaniſh* flies in powder, ſix drachms, or one ounce. Putting firſt the *Burgundy* pitch, ſhip pitch, and roſin in a pipkin, to melt over a ſlow fire, ſtirring them to make them incorporate; when melted, put in the *lapis infernalis* in powder, ſtirring it all the while that it may equally mix: laſtly, put in by degrees the ounce of cantharides in powder, ſtirring them likewiſe as you have done the *lapis infernalis*, and for the ſame end; but if you perceive that the powders make it too thick, you may at your diſcretion, add a little of the rankeſt oil you can get, taking care that it ſhould not boil after the *Spaniſh* flies are in, nor remain long on the fire, otherwiſe it would loſe its virtue; therefore about a minute or two after the powder of the *Spaniſh* flies is all ſtirred in, take it off the fire and keep it for your uſe; and when you uſe it ſpread it pretty thick upon leather, and apply it to the part, where it muſt remain ten or twelve hours; then when you dreſs it, cut all the bliſters that are not broken, and wipe them clean, applying to the parts the following plaiſter.

Take four heads of garlick, one ounce of *Venice* treacle, half an ounce of *Venice* turpentine, half an ounce of the filings of pewter, and one drachm of the powder of *Spaniſh* flies, half an ounce of honey, and two drachms of verdigreaſe in powder, pounding all theſe together in a mortar; when you uſe it ſpread it on leather and apply it, binding it on, by reaſon that it is not very apt to ſtick: but when the

the bite is on a part the plaiſter cannot be conveniently bound on, then the leather muſt be cut ſomething broader than what is neceſſary for the plaiſter, in order that the margin may be ſpread with *Burgundy* pitch; then put the plaiſter in the middle of the leather, and the *Burgundy* pitch on the margin will make it ſtick without binding. This plaiſter muſt lie on twenty-four hours, and then taken off, and the part cleanſed, and the plaiſter renewed; keeping the ſores open as long as poſſile with this plaiſter, in order to draw the venom that it get not into the blood, which would kill the horſe.

Beſides theſe outward applications for putting a ſtop to the venom, inward remedies are alſo uſed to ſubdue and drive it out, in caſe it ſhould have ſeized the maſs of the blood, and alſo to prevent its getting there. The following diet drink is of great efficacy in thoſe caſes.

Take of the leaves of box, the leaves of rue, the leaves and roots of primroſe, the leaves of ſage, of each two handfuls; three quarters of a pound of freſh roots of the male piony, three ounces of the powder of crabs claws, two ounces of round birthwort roots in powder, three ounces of *Venice* treacle: bruiſe all theſe things together in a mortar, then put it in a glaſs or earthen pot, and pour upon the ingredients four quarts of white *Liſbon* wine, or for want of it, of the beſt cyder, or ſtrong beer; then ſtop the glaſs or pot ſlightly, putting it to infuſe in a kettle of hot water for the ſpace of twelve or fourteen hours, then keep it for uſe. When you uſe it, you muſt ſtrain off about a pint, into which you muſt put about a drachm of balſam of ſulphur, and give it your horſe in a drenching horn in the morning, letting the horſe faſt two hours after, and repeating it thrice.

The *eyes* of horſes are alſo ſubject to a number of different diſeaſes, as *pin* and *web*, *pearls*, *clouds*, *bloodſhot*, *ſore* and *running eyes*, *ſalt*, *hot*, and *ſharp rheums*, *ulcers*, *fiſtula's*, *bruiſes*, *ſtripes*, &c. for all which the following *eye-water* is a ſovereign remedy.

Take a new earthen pipkin which will hold five pints or three quarts, put into it of the ſtone called *lapis calaminaris* in powder, of the beſt bole armenick, alſo in powder, and of the beſt white vitriol, of each an ounce and a half; boil them over a gentle fire till it be reduced to a quart, then let it ſettle, and pour the clear from the *fæces*, adding to the water three drachms of ſugar of ſaturn, three drachms of ſalt of vitriol, half an ounce of camphire diſſolved in ſpirit of wine, an ounce of tincture of aloes, three drachms of tincture of opium, one quart of roſe-water, and half an ounce of prepared tutty; mix all together and keep it in a bottle for uſe.

If your horſe be troubled with any doſe in his head, give him muſtard-ſeed among his provender, but if it be a worſe cold, which you will perceive by his rattling, then give him the following electuary.

Take honey and treacle, a pound of each, having mixed theſe together, add to them cumin-ſeeds in powder, liquorice, bay-berries, anniſeeds, of each an ounce; theſe likewiſe muſt be mixed together, and afterwards with the honey and treacle, which will make it of a thick conſiſtence. If your horſe has a cold, inſtead of his oats before water, give him the quantity of a walnut of this lambitive, at the end of a ſtick or in a ſpoon, and let him lick it off; doing the ſame after airing, when firſt you come in, and your horſe will ſoon be cured.

The *lameneſs* of a horſe is alſo worthy our notice; which, if it proceeds from old ſtrains, you muſt cure with the following ointment.

Take freſh butter, oil of bays, dralthea and turpentine, of each two ounces, mix and boil them together on a gentle fire; and when they are well incorporated anoint the horſe twice a day with it as hot as he can bear it, and give him exerciſe, by airing him abroad morning and evening a foot-pace; and you'll find it a ſovereign remedy for any ſtrain in the ſhoulder, clap on the back ſinews, or any grief whatſoever that proceeds from ſtrains.

But if you only fear *lameneſs* from old ſtrains, then you muſt take care that your exerciſe be moderate, and always when you return from water, and his legs are rubbed dry, anoint them with ſuch ointments as are accounted good for the limbs, as *linſeed*, *train*, *ſheep's-foot*, *neat's-foot*, *nerve oil*, and the like; all which may be uſed on his days of reſt, but on his heating days, urine and ſaltpetre. Some *horſemen* uſe brandy and ſallad oil mixed, and bathe his legs, and afterwards heat it in with a hot iron, and commend it as the beſt thing for the limbs of an old ſtiff horſe.

But if your horſe through negligence or any caſualty, happens to have the greaſe fall into his heels, you muſt endeavour to remove it by a good ſound heat, and a ſcowering after it, applying to his legs this poultice.

Take a pound of honey, turpentine, common gum, meal of linſeed and of fenugreek, of each four ounces, bay-berries in powder, three ounces: mix and boil all theſe together; then take it off and add to it a pint of white wine, boiling it over again.

gain till it be very thick; and with this as hot as the horse can bear it, lap his legs about, renewing it only once in three days, if your horse's feet be bad, either surbated or founder'd; then instead of cow-dung, you may stop them with blue clay and vinegar tempered together.

HUNTING.

HUNTING is the art, exercise, or diversion of pursuing beasts of venery, or chace; and certain birds, as pheasants, partridges, *&c.*

There are several statutes for punishing offences committed by persons not qualified by law, to take or destroy the game.

The antient laws ordain, that no person shall take pheasants or partridges, with engines in another's ground, without his license, on forfeiture of 10*l.* and persons killing any pheasant, partridge, pigeon, duck, hare, or other game, forfeits 20*s.* for every fowl, hare, *&c.* 11 *Hen.* VII. 1 *Jac.* I. c. 17. Constables having a justice of peace's warrant, may search the houses of suspected persons for game; and in case any be there found, and they do not give a good account how they came by it, such persons shall forfeit for each hare or pheasant, partridge, *&c.* not under 5*s.* nor exceeding 20*s.* Likewise by another statute, if any higler, chapman, carrier, inn-keeper, or victualler, shall have in his custody any hares, pheasants, partridges, heath-game, *&c.* he forfeits for every hare and fowl, 5*l.* unless the same be sent by a person qualified to kill game. The selling or offering game to sale is made liable to the like penalty; and in that case, if any hare, *&c.* be found in a shop, *&c.* it is deemed exposing it to sale.

Persons not qualified, keeping dogs, nets, or engines to kill game, on their conviction before a justice of peace, shall also pay 5*l.* or be sent to the house of correction for three months, 4 and 5 *W.* and *M.* c. 23. 5 *Ann.* c. 14. 9. *Ann.* The penalties for destroying game, are recoverable by action, as well as before justices of peace, by 8 *Geo.* I. c. 19. If a person hunts any game on the land of another, such other cannot justify the killing of his dogs. Where one in hunting starts a hare upon his own land, and then follows and kills such hare in another person's ground, it is lawful, and the game is his own; but where a man starts a hare on another's land, and kills it there, he is subject to an action of trespass.

Hunting is practised in a different manner, and with a different apparatus, according to the different nature, genius, and address, of the particular beast which is the object thereof. These beasts are, the *hart*, *hind*, *hare*, *boar*, *wolf*, *buck*, *doe*, *fox*, *marten*, and *roe*; the five first whereof are denominated beasts of the forest, or venery; and the five latter beasts of the field, or of chace.

Every gentleman, who wants to render himself perfect in this noble exercise, must study those terms proper to the diversion, and learn their true signification.

These terms are either appropriated to the *beasts*, which are hunted, or the *dogs* employed in hunting them. Those peculiar to the different kinds of beasts hunted, are either to express their *names*, *seasons*, *degrees*, and *ages of forest*, or *venery*, *chace*, *warren*, &c. or to signify their different *societies*, their *lodging*, *dislodging*, their *noise* at *rutting-time*, their *copulation*, their *footing* and *treading*, the *different parts* of their bodies, the *flying*, *stripping*, and casing them, *&c.* Thus the HART is called the first year a *hind-calf*, or *calf*; the second year, a *knobber*; the third year, a *brock*; the fourth year, a *staggar*; the fifth year a *stag*; the sixth year a *hart*.—If the king or queen happen to chase him, and he escapes with his life, he shall ever after be called a *hart royal*.

The HIND is called, the first year, a *calf*; the second year, a *hearse*; the third year, a *hind*.

The HARE is called, the first year, a *leveret*; the second year, a *hare*; the third year, a *great hare*.

The WILD BOAR is called, the first year, a *pig of the sounder*; the second year, a *hog*; the third year, a *hog's steer*; the fourth year, a *boar*; at which age, if not before, he leaves the *sounder*, and then he is called a *singler*.

The above mentioned beasts are what we have called already *beasts of forest*, or *venery*; and that they make their abode all the day-time, in the great coverts and secret places in the woods; and at night repair to their lawns, meadows, pastures, and pleasant feeding places.

These that follow are *beasts of chace*, viz. the BUCK is called the first year, a *fawn*; the second year, a *pricket*; the third year, a *sorrel*; the fourth year, a *sore*; the fifth year, a *buck of the first head*; the sixth year, a *great buck*.

The DOE is called, the first year, a *fawn*; the second year, a *tegg*; the third year, a *doe*.

The

The Fox is called, the firſt year, a *cub*; the ſecond year, a *fox*; and afterwards an *old fox*.

The MARTEN is called, the firſt year, a *cub*; the ſecond year, a *marten*.

The ROE is called, the firſt year, a *kid*; the ſecond year, a *girl*; the third year, a *hemuſe*; the fourth year, a *roe-buck of the firſt head*; the fifth year, a *fair roe-buck*.

The beaſts of chaſe reſide all the day-time in the fields, or upon hills and mountains, where they may be ſeen afar off, to prevent danger; but when night approaches, they feed, as the reſt in meadows, *&c.*

The *Hart* or *Buck* ſeaſon begins 15 days after *Midſummer-day*, and laſts till *Holy-Rood-Day*. — The *Fox* at *Chriſtmas*, and laſts till the *Annunication of the Bleſſed Virgin*. — The *Hind*, or *Doe*, begins at *Holy-Rood-day*, and laſts till *Candlemas*. — The *Roe-buck* begins at *Eaſter* and laſts till *Michaelmas*. — The *Hare* begins at *Michaelmas*, and laſts till the end of *February*. — The ſeaſon of the *Wolf*, is ſaid to be from *Chriſtmas* till the *Lady-Day*. — Laſtly, the *Boar*, begins at *Chriſtmas*, and continues to the *purification*, *Candlemas*.

The terms uſed for beaſts of *venery* and *chace*, as they are *in company*, are theſe. — They ſay a *Herd of Harts*, and of all manner of *Deer*. — A *Bevy of Roes*. A *Sounder of Swine*. — A *Route of Wolves*. — A *Richeſs of Martens*. — A *Brace* or *Leaſh of Bucks*, *Foxes*, or *Hares*. — A *couple of Rabbits*. — A *couple of Coneys*.

To expreſs their *Lodging*. — A Hart is ſaid to *harbour*. A Buck *lodges*. — A Roe *beddeth*. — A Hare *ſits* or *formeth*. — A Coney *ſitteth*. — A Fox *kennelleth* — A Marten *treeth*. — An Otter *watches*. — A Badger *eartheth*. — A Boar *couches*.

Terms for their *Diſlodging*. — They ſay *unharbour* the Hart. — *Rouſe* the Buck. — *Start* the Hare. — *Bolt* the Coney. — *Unkennel* the Fox. — *Tree* the Marten. — *Vent* the Otter. — *Dig* the Badger. — *Rear* the Boar.

The terms for their *Noiſe* at *Rutting-time*, are as follow. — A Hart *belleth*. — A Buck *groweth*, or *troateh*. — A Roe *belloweth*. — A Hare *beateth* or *tappeth*. — An Otter *whineth*. — A Boar *freameth*. — A Fox *breeketh* — A Badger *ſhricketh*. — A Wolf *howleth* A Goat *rattleth*.

Terms for their *Copulation*. — A Hart, or Buck, goes to *rut*. — A Roe goes to *turn*. — A Boar goes to *brim* A Hare and Coney goes to *buck*. — A Fox goes to *clicketting*. — A Wolf goes to *match* or to *make*. — An Otter *huſtles for his kind*.

Terms for the *Footing* and *Treading*. — Of a Hart we ſay the *Slot*. — Of a Buck, and all Fallow Deer, the *View*. — Of all Deer, if on the graſs, and ſcarce viſible, the *Foiling*. — Of a Fox, the *Print*: and of other like vermin, the *Footing*. — Of an Otter, the *Marks*. — Of a boar, the *Track*. — The Hare, when in open field, is ſaid to *ſore*; when ſhe winds about to deceive the hounds, ſhe *doubles*; when ſhe beats on the hard highway, and her footing comes to be perceived, ſhe *pricketh*; in ſnow it it called the *trace of the Hare*.

Every part of each beaſt has always its different name, expreſſed by a different term, according to the different kinds of beaſts.

Therefore the *tail* of a Hart, Buck, or other deer, is called the *ſingle*; that of the Boar, the *wreath*; of a Fox, the *bruſh* or *drag*, and the tip at the end is called the *chape*; of a Wolf, the *ſtern*; of a Hare and Coney the *ſcut*.

The terms for the *Attire* of *Deer* — Thoſe of a Stag, if perfect, are the *bur*, the *pearls*, the *little knobs* on it, the *beam*, the *gutter*, the *antler*, the *ſur-antler*, *royal*, *ſur-royal*, and all a-top, the *croches*.

Of a *Buck*, the *bur*, the *beam*, *brow-antler*, *black-antler*, *advancer*, *palm*, and *ſpellers*.

If the *croches* grow in the form of a man's hand, it is called a *palm'd head*. Head bearing not above three or four, and the *croches* placed aloft, all of one height, are called *crown'd heads*. Heads having double *croches*, are called *forked heads*, becauſe the *croches* are planted on the top of the beam like forks.

If you be aſked what a *Stag* bears, you are only to reckon the *croches* he bears, never expreſſing an odd number: As if he has four *croches* on his near horn, and five on his fur, you are to ſay he bears ten, a falſe *right* on his near horn (for all that the beam bears, are called *rights*.) If but four on the near horn, and ſix on the far horn, you muſt ſay he bears twelve, a double falſe *right* on the near horn. For you ought not only to make the number even, but alſo the horns even, with that diſtinction.

The very ordure of the beaſts, is expreſſed by different terms; for,

The *excrement* of a Hart, and all Deer, is called *fewmets*, or *fewmiſhing*. — Of a Hare, *crotiles*, or *crotiſing*. — Of a Boar, *leſſes*. — Of a Fox, the *billeting*; and of other the like vermin, the *fuants*. — Of an Otter, the *ſprainte*.

All kind of *Deers fat*, is called *ſuet*. — Of a Boar, *greaſe* — Of a Roe, *heavy-greaſe*.

They ſay a *litter* of Cubs, a *neſt* of Rabbits, a Squirrel's *dray*.

The terms for *ſlaying*, *ſtripping*, and *caſing* all manner of chaces, are as follow. — The Hart, and all ſort of Deer, are *ſlain*. The Hare *ſtripped*, or *caſed*; and ſo is the boar. — The Fox, the Badger, and all manner of vermin, are *caſed*.

Veniſon,

Veniſon, is thus called from the manner of taking the beaſt by *hunting*, called in the *Latin*, *venatio*. No beaſt of the foreſt, that is *Solivagum & nocivum*, is *Veniſon*, as the Fox, the Wolf, the Marten, becauſe they are not meat.

From this we conclude, that whatſoever beaſt of the foreſt is for the food of man, is *Veniſon*; and that any beaſt that is not for the food of man, is not *Veniſon*.

Being ſo far advanced in the dialect of hunting, we may provide dogs, called *Hounds*.

Hounds may be diſtinguiſhed with regard to their manner of *hunting*, into ſuch as find out, and purſue the game by ſight, and the quickneſs and ſwiftneſs of their motion; of which kind are the *Gaze-hound*, *Gray-hound*, the *Terrier*, &c. And thoſe which find and purſue the game by the goodneſs of their ſmell.

The ſpecies of *hunting* dogs may be divided further into *hounds*, ſimply ſo called, and *Blood-hounds*, each whereof admit of ſome diverſity.

1. As to the *Hounds*, ſimply thus called, thoſe which are all of one colour, as white, black, &c. are more valued than thoſe ſpotted with red. Thoſe ſpotted with dun are little priz'd, as wanting courage and boldneſs. Fallow *Hounds* are of good ſcent and hardy, not fearing the water. They keep the chace well without change; but not ſo ſwift as the white. They love the Hart above any other chace, having little ſtomach for the Hare, &c. whence they are not ſo fit for private gentlemen, beſides that they are apt to run at tame beaſts.

The *dun Hounds* are of a more general uſe, being fit for all chaces. Their ſagacity and fidelity in knowing and ſticking to their maſter's voice and horn, and none elſe, are much admired.

The marks of a good and fair *Hound*, are to be of a middle proportion, rather long than round; the noſtrils wide; back bowed; fillets great; haunches large; the thighs well truſſed; the ham ſtrait; tail big near the reins, and the reſt ſlender to the end; the leg big; the ſole of the foot dry, and form'd like a Fox, and large claws

To chuſe a dog and a bitch for good whelps, you muſt take a bitch that comes of a good kind; ſtrong, and well proportioned in all parts, with large ribs and flanks.—The dog, that lines her, muſt be of a good breed, and likewiſe young, if you'll have light and hot *hounds*; for if the dog be old, the whelps will participate of his dull and heavy nature.—If the bitch does not grow naturally proud, ſo ſoon as you would have her, you may make her ſo by taking two heads of garlick, half a caſtor's ſtone, the juice of creſſes, and about twelve Spaniſh flies, boiling theſe together in a pipkin which holds a pint, with ſome mutton to make broth of it; and of this give to the bitch tw thrice, and ſhe will infallibly grow proud. The ſame pottage given to the dog, will make him deſirous of copulation.—When the bitch is lined, and with puppy, ſhe muſt not hunt, otherwiſe ſhe would caſt her whelps; but let her, without being confined, walk up and down the houſe and court, and never lock her up in her kennel; for ſhe is then impatient of food; and therefore you muſt make her ſome hot broth once a day.—If you would ſpay your bitch, it muſt not be done before ſhe ever had a litter of whelps; and in ſpaying her, take not away all the roots or ſtrings of the veins; for if you do, it will much prejudice her reins, and hinder her ſwiftneſs ever after; but by leaving ſome behind, it will make her much the ſtronger and more hardy. Whatever you do, ſpay her not when ſhe is proud; for that would endanger her life: but you may do it fifteen days after. The beſt time of all is when the whelps are ſhaped within her.

To enter a young *hound*, after having taught him to know the hallow, and the ſound of the horn, at about eighteen months old he may be taken into the field. The beſt method to initiate him is, to take a live hare, and trail her upon the ground, this way, then that; and at length hide her at a proper diſtance. Then ſetting the *hound* near the trail, he will take wind, and run to and fro about the fields, woods, paſtures, path ways, and hedges, till he finds which way the hare is gone, but with a ſoft and gentle pace, till coming near the place where ſhe is lodged, he mends it, and at laſt leaps on his prey, which he muſt be ſuffered to kill, and bringing it to his maſter with triumph, muſt be rewarded and encouraged. This done, he may be let run in a pack of old *hounds* to confirm and perfect him.

Whatever young *hounds* are firſt enter'd at, and rewarded with, they will ever after covet moſt; ſo that if they be intended, *v. gr.* for the hart, they muſt not be entered at the hind. And for the better hunting the hart, young *hounds* are not to be entered within a toil; for there a hart does nothing but turn and caſt about, ſince he cannot run endways, and thus they are always in ſight of him.—Neither are the *hounds* to be enter'd or taught in the morning; otherwiſe they will give over in the heat of the day.

2. The *Gray-hound* might deſerve the firſt place, by reaſon of his ſwiftneſs, ſtrength, and ſagacity in purſuing his game; ſuch being the nature of this dog, that he is well ſcented to find out, ſpeedy and quick of foot to follow, fierce and ſtrong to overcome, yet ſilent, coming upon his prey unawares.

The

The make and proportions requir'd in a good *Gray-hound* are, that he have a lean and long head, with a ſharp noſe, ruſh grown from the eye downwards; a full clear eye, with long eye-lids: a ſharp ear, ſhort and cloſe falling; a long neck a little bending, with a looſe hanging weaſand; a broad breaſt, ſtrait forehead, hollow ſide, ſtrait ribs, a ſquare flat back, ſhort and ſtrong fillets, a broad ſpace between the hips, a ſtrong ſtern or tail, a round foot, and good large cleſts.

In the breeding of *Gray-hounds*, it is obſerved, that the beſt dog upon an indifferent bitch, will not get ſo good a whelp, as an indifferent dog upon the beſt bitch. That the dogs and bitches muſt be, as near as poſſible, of an equal age, not exceeding four years old; however, the beſt means which can be uſed to produce excellent whelps, is to breed with a young dog and an old bitch. That the dieting of *Gray-hounds* conſiſts in the food, exerciſe, airing, and kennelling. The common food of *Gray-hounds* ought to be raſpings, cruſts of bread, ſoft bones, and griſtles. The raſpings to be ſcalded in beef, mutton, veal, or veniſon broth; and when it is indifferently cold, then make your bread only float with good milk, and give it your *Gray-hounds* morning and evening; which will keep them in good ſtate of body. But if your dog be poor, ſickly, and weak, then take ſheep's heads, wool and all, clean waſhed, and having broken them to pieces, put them into a pot, ſcumming it when it boils, putting in it a good quantity of oatmeal; and making it boil till the fleſh be very tender, then with your meat and broth, feed your dogs morning and evening; this will recover them. As to the exerciſe of a *Gray hound*, it conſiſts in two things, *viz.* in courſing and airing. As to the firſt, he ought to be practis'd twice a week, in ſuch a manner that you uſually reward him with blood, which will animate and encourage him to purſue his game; taking care to give the hare all reaſonable advantage, ſo that ſhe may ſtand long before the *Gray-hound*, that thereby he may ſhew his utmoſt ſtrength and ſkill before he reaps the benefit of his labour. If he kills, do not ſuffer him to brake the hare, but take her from him, and having cleanſed his chaps of the wool of the hare, give him the liver, lights, and heart, and ſo take him in your leaſh, and having led him home, waſh his feet with ſome butter and beer, and then put him in his kennel, and feed him half an hour afterwards.

The huntſman is to lead theſe *hounds* on his left hand, if he be on foot; and on the right, if on horſe-back. The beſt time to try and train them to the game, is at twelve months old, though ſome begin ſooner, with the males at ten, and the females at eight months old, which laſt are generally more ſwift than the dogs: they ſhould be kept in a ſlip while abroad, till they ſee their courſe; neither ſhould you looſen a young dog till the game has been a conſiderable time on foot, being apt, by over-eagerneſs at the prey, to ſtrain his limbs.

3. The *Gaze-hound*, or *Beagle*, is a dog more beholden to the ſharpneſs of ſight, than to his noſe or ſmelling, by virtue whereof he makes excellent ſport with the fox and hare. He is alſo noted as exquiſite in chuſing of one that is not lank or lean, but full, fat, and round, which, if it happens to return, and be mingled again with the reſidue of the herd, he will ſoon ſpy out, and leave the reſt untouched, never ceaſing after he has ſeparated it from its company, till he has worried it to death.

4. There is in *Scotland* a kind of hunting dogs called *Sluth Hounds*, moſt of them of a browniſh colour, or ſandy-ſpotted. Their ſenſe of ſmelling is ſo quick, that they can follow the foot-ſteps of thieves, and purſue them with violence till they overtake them; nay ſhould the thief take the water, they are ſo eager in their purſuit that they will ſwim after them, and are reſtleſs till they find the thing they ſeek after.

5. The *Blood-Hound* differs nothing in quality from the *Scotch* ſluth hound, ſaving that it is longer ſized, and not always of the ſame colour; but ſometimes red, ſanded, black, white, ſpotted, *&c.* though moſt commonly either red or brown.

Their nature is, that being ſet on by the voice and words of their leader, to caſt about for the ſetting of the preſent game, and having found it, they will never ceaſe purſuing it with full cry till it be tired, without changing for any other.

They ſeldom bark, except in their chace, and are very obedient and attentive to the voice of their leader. Thoſe that are really good, when they have found the hare, make ſhew thereof to the huntſman, by running more ſpeedily, and with geſture of head, eyes, ears, and tail, winding to the ſorm or hare's muſe, never giving over proſecution without a gallant noiſe.

They have good and hard feet, and ſtately ſtomachs, and are very properly denominated *blood-hounds*, by reaſon of their extraordinary ſcent; for if their game be only wounded, ſo that it eſcapes the huntſman's hands, or if it be killed and never ſo cleanly carried away, theſe dogs by their exquiſite ſmell will diſcover it, and not be wanting either by nimbleneſs or greedineſs to come at it, provided there be any ſtains of blood. Nay, though by all the cunning and foreſight imaginable, a beaſt be conveyed away without ſpot or blood, yet through the roughbeſt and moſt crooked ways and meanders, will this dog find out the deer-ſtealer, and even in

the thickeſt throng, will by his ſmell ſeparate and pick him out.

The *Terrier* or *Harrier*, only hunts the fox or badger, being thus called, becauſe after the manner of ferrets in ſearching for conies, he leaps into the ground and affrights and attacks the beaſt, either tearing them in pieces, or haling them out by force, or at leaſt driving them out of their harbours, to be taken in a net or otherwiſe.

The huntſmen having commonly a couple of terriers they may put in a freſh one, as occaſion requires, to relieve the other.

The time of entering the terrier, is when he is near a twelvemonth old: if it be not done within that time, they will hardly be brought to take the earth; this entering and ſteſhing of them may be performed ſeveral ways. Firſt, when the foxes and badgers have young cubs, take an old terrier, ſet him into the ground, and when he begins to bay, hold the young one at the hole or mouth of the earth, that he may liſten and hear the old one bay.

The old fox or badger being taken, ſo that nothing remains within but the cubs, couple up the old ones, and put in the young ones in their room, encouraging them by crying, *to him, to him.* If they take any cub within, let them do with him what they will; not forgetting to give the old terriers their reward, which is blood and liver fried with cheeſe and ſome of their greaſe; ſhewing them head and ſkin to encourage them.

6. The *Leviner* or *Lyemmer*, is ſingular in his ſmell, and in ſwiftneſs incomparable. He is of a middle kind between the terrier and the gray-hound, as well for his kind as for the ſhape of his body. The *French* uſe it in hunting the wolf.

Being provided with *hunting dogs*, we muſt next learn the terms uſed in reſpect of them; therefore of *gray-hounds* two make a *brace*; of hounds a *couple*. Of gray hounds three make a *leaſh*; of hounds *a couple and a half*. — They ſay, *let ſlip* a gray-hound, and *caſt off* a hound. — The ſtring wherein a gray-hound is led, is called a *leaſh*, and that of a hound, a *lyom*. The gray-hound has its *collar*, and the hound his *couples*. They ſay, a *kennel* of hounds, and a *pack* of beagles.

When the hounds or beagles hit the ſcent of their chace contrary, as to hit it up the wind when they ſhould hit it down, we ſay, they *draw amiſs*.

When the hounds or beagles take freſh ſcent, hunting another chace till they ſtick and hit it again, we ſay, they *hunt change*.

When the hounds or beagles hunt it by the heels, we ſay, they *hunt counter*.

When the chace goes off and comes on again, traverſing the ſame ground to deceive the hounds or beagles, we ſay, they *hunt the foil*.

When we ſet hounds in readineſs, where we expect the deer will paſs, and then caſt them off, when the other hounds are paſſed by, we account that *a relay*.

When the hounds or beagles have finiſhed their chace, by the death of what they purſued, and then in requital, are fed by the hands of the huntſman or others, we call that their *reward*.

Huntſmen, when they go drawing in their ſprings at hart's hunting, uſually make due rounds, which we call *ring-walks*.

When any deer is hard hunted, and then betakes himſelf to ſwimming in any river, *&c.* we ſay, he *takes ſoil*.—When deer caſt their horns, we ſay, *they mew*. The firſt head of a fallow deer is called a *prick*.

When huntſmen endeavour to find a hart by the ſlot, *&c.* and then mind his ſteps, to know whether he be large and long, they ſay then, that they know him by his *gait*.

When deer rub, and puſh their heads againſt trees, to cauſe the peel of their new horns to come off, we ſay, *they fray*.—When after being hard run, they turn head againſt the hounds, we ſay, *they bay*.

When hounds or beagles run along without opening, or making any cry, we ſay, *they run mute*.

When hounds or beagles at firſt finding the ſcent of their game, open and cry, we ſay, *they challenge*.—When hounds run at a whole herd of deer, we ſay, *they run riot*.—When the hounds touch the ſcent, and draw on till they rouze or put up the chace, we ſay, *they draw on the ſlot*.

When a roe croſſes and doubles, it is called *trajecting*.

When a hare takes the ground like a coney, which ſeldoms happens, we ſay, *ſhe goes to the vault*.

When we beat the buſhes, *&c.* after the fox, we call it *drawing*.

When a hare runs on rotten ground, or in a froſt, which ſticks to her feet, we ſay, *ſhe carrieth*.

When beagles bark and cry at their prey, we ſay, they *yearn*. A red male hart of a year old, is called a *ſpitter*.

A *rein-deer*, is a beaſt like a hart, but has his head fuller of antlers.

A *pricker*, is a huntſman on horſeback.

Enginea to take deer withal, are called *wiles*.

When we ſet hounds or beagles in readineſs, expecting the chace to come by, and then caſt them off before the reſt come in, we call it a *vauntlay*.

When hounds or beagles find where the chace has been, and made a proffer to enter but returned, we ſay, *there it a blemiſh*.

The *call*, is a leſſon blowed on the horn to comfort the hounds.—A *recheat*, is likewiſe a leſſon blown

blown on the horn.—The *mort* or *death*, is a leſſon blown at the death of any deer.

A dog is ſubject to ſeven ſorts of madneſs, *viz.* the *hot burning madneſs*, *running madneſs*, *dumb madneſs*, *falling madneſs*, *lank madneſs*, *ſleeping madneſs*, *rheumatick* or *ſlavering madneſs*; and the *mange*.

The two firſt of theſe *madneſſes* are incurable, *viz.* the *burning* and the *running madneſs*.

The ſymptoms of the *burning madneſs* are theſe: when the dogs run, they raiſe their tails bolt upright, and run upon any thing that ſtand before them, having no regard where, nor which way they run; alſo their mouth will be very black, having no foam in or about it. They will not continue thus above three days, before they die. All dogs they have bitten and drew blood from will be mad likewiſe.

The *running madneſs* is leſs dangerous, though incurable. The dogs afflicted therewith run not on men, but on dogs, and other beaſts. The ſymptoms are, they will ſmell on other dogs, and having ſmelt them will ſhake and bite them, yet ſhaking their tails, and ſeeming to offer no harm.

The *dumb madneſs* is curable, and is thus diſcovered; the dog that is troubled with it will not feed, but continually hold his mouth wide open, putting often his feet to his mouth, as if he had a bone in his throat. The cure is this; put four ounces of the juice of *ſpatula putrida* into a pot, taking the like quantity of the juice of black *hellebore*, and as much of the juice of *rue*, ſtraining them all well through a fine cloth, and putting them into a glaſs; then take two drachms of ſcammony unprepared, and having mixed it with the juices, put it into a horn or funnel, and convey it down his throat, keeping his head up ſtrait leſt he caſt it up again; then bleed him in the mouth, cutting three or four veins in his gums, that he may bleed the better. Or you may only take eight drachms of the juice of an herb called hartſhorn or dog's-tooth, and you'll find it a moſt excellent receipt againſt any madneſs whatever.

The *falling madneſs* lies in their heads, which makes them reel as they go, and then fall.—The cure is this: take four ounces of the juice of piony, with the like quantity of the juice of briony, the like of the juice of *cruciata*, and four drachms of ſtavefacre pulverized; mix theſe together, and give it your dog or hound as aforeſaid, then let him blood in the ears, or the two veins which come down the ſhoulders; and if he be not cured at firſt, give him a ſecond or third doſe.

The *lank madneſs*, thus called by reaſon of the leanneſs of their bodies, is occaſioned by *ſkummering*.—The cure is thus performed: firſt purge your dog with this potion; take an ounce and a half of *caſſia fiſtularis* well cleanſed, two drachms and a half of ſtavefacre pulverized, and the like quantity of ſcammony prepared in white-wine vinegar, and four ounces of oil of olive, temper theſe and warm them over the fire, and give it your dog. In the morning put him into this bath faſting; put into ſix palls of water ten handfuls of mugworth, of roſemary, of red ſage, the roots or leaves of marſh-mallows, the roots or leaves of wall-wort, the roots or ſtalks of fennel, the roots or leaves of elecampane, balm and rue, ſorrel, bugloſs, and melilot; let theſe boil together in two thirds of water, and the other of wine, to the conſumption of one third; the bath being no hotter than your dog can endure it, bathe him in it for the ſpace of an hour, then taking him out, put him in ſome warm place for fear of catching cold; which ſhould be repeated four or five times to perfect the cure.

The *ſleeping madneſs*, is cauſed by ſome little worms breeding in the entrance of the ſtomach from corrupt humours, the vapours and fumes whereof aſcending into the head make the dog ſleep continually, ſometimes till he dies ſleeping. For the cure, you muſt take five ounces of the juice of wormwood, with two ounces of burnt hartſhorn in powder, and two drachms of agarick; mix them together, and if they be too thick add white-wine, and give it your dog to drink.

The *rheumatick* or *ſlavering madneſs*, is thus called, becauſe when a dog is afflicted with it, his head ſwelleth, his eyes are very yellow, and he commonly ſlavereth at the mouth. The cure is performed thus; take ſix ounces of the juice of fennel-roots, and the like quantity of the juice of miſſeltoe, four ounces of the juice of ivy, four ounces of the roots of polipody in powder; boil theſe in white-wine, and give it your dog to drink as hot as he can ſuffer it.

The *mange* frequently proceeds from want of freſh water or drink, when a dog deſires it, and ſometimes by foul kennelling, ſometimes likewiſe by foundering and melting his greaſe. To cure this diſtemper, take two handfuls of wild creſſes, two handfuls of elecampane, as much of the leaves and roots of rhubarb and ſorrel, and two pounds of the roots of ſtodels, which muſt be all well boiled in lie and vinegar: having ſtrained the decoction, put in it two pounds of gray ſoap, and when it is melted, rub your dog with it four or five days together, and it will cure him.

There are ſome other terms and deſcriptions, particularly thoſe relating to *forſt* and *foregut*, which muſt be learned before we can reckon ourſelves perfectly well verſed in the art of *hunting*.

A Forest is a certain territory of woody grounds, and fruitful pastures, privileged for wild beasts, and fowls of forests, chace, and warren, to rest and abide in the same protection of the king, for his princely delight; bounded with unremoveable marks and meers, either known by matter of record or prescription; replenished with wild beasts of venery and chace, and with great coverts of vert, for succour of the said beasts; for preservation and continuance whereof, with the vert and venison, there are certain peculiar laws, privileges, and officers.

All the ground adjoining to forests, is called a *purlieu*, and a purlieu-man is he that hath ground within the purlieu, and 40*s.* a year freehold, which entitles him to hunt, though with some caution, within his own purlieu.

The officers of a forest are, a forester, regarder, ranger, verderer, agistor, *&c.*

A Chace is a place appointed to receive deer and beasts of the forests; in this it differs from a *forest*, that it may be in the hands of a subject; but a *forest*, properly speaking, cannot; and from a *park*, in that it is not inclosed like it, and has a larger compass, a greater store of game, and more keepers, and overseers.

The terms peculiar to forests, chaces, parks, *&c.* necessary for the knowledge of huntsmen, are thus explained:

Expeditate, is the cutting off (according to Mr. *Manwood*) the three fore-claws of the foot of a great dog, by the skin; and that the owner of every such dog, unexpeditated in the forest, shall forfeit 3*s.* 4*d.*

Fence month, hath 31 days, begins 15 days before *Midsummer*, and ends 15 days after; in which time it is unlawful to hunt in the forest, or to go among the deer to disquiet them; because it is the time of fawning.

Frank chace, is a liberty of free chace in a circuit annexed to a forest, whereby all those that have ground within the circuit, are forbidden to cut down wood, or discover, *&c.* within the view of the forester, though it is his own demesne.

Footgeld, is an amercement on such as live within the forest, for not expeditating their dogs. And to be quit of *footgeld*, is a privilege to keep their dogs unlawed, without any penalty.

With these instructions a sportsman may venture to take the field, on such a horse as he'll find described in the treatise on *horsemanship*; observing the following directions.

In Badger-hunting, you must begin with seeking the earths and burrows where he lies, and in a clear moonshine-night go and stop all the burrows, except one or two, and therein place some sacks, fastened with drawing strings, which may shut him in as soon as he straineth the bag. Some use no more than to set a hoop in the mouth of the sack, and so put it into the hole; and as soon as the badger is in the sack and straineth it, the sack slippeth off the hoop and follows him into the earth, so he lies tumbling therein till he is taken. These sacks or bags being thus set, cast off the hounds, beating about all the woods, coppices, hedges, and tufts, round about, for the compass of a mile or two, and what badgers are abroad, being alarmed by the hounds, will soon betake themselves to their burrows; and observe that he who is placed to watch the sacks, must stand close and upon a clear wind; otherwise the badger will discover him, and will immediately fly some other way into his borrow. But if the hounds can encounter him before he can take his sanctuary, he will then stand at a bay like a boar, and make good sport, grievously biting and clawing the dogs, for the manner of their fighting is lying on their backs, using both teeth and nails; and by blowing up their skins defend themselves against all bites of the dogs, and blows of the men upon their noses as aforesaid. And for the better preservation of your dogs, it is good to put broad collars about their necks made of greys skins.

When the badger perceives the terriers to begin to yearn him in his burrow, he will stop the hole betwixt him and the terriers; and if they still continue baying, he will remove his couch into another chamber, or part of the burrow, and so from one to another, barricading the way before them, as they retreat, until they can go no further. If you intend to dig the badger out of his burrow, you must be provided with the same tools as for digging out a fox; and besides, you should have a pail of water to refresh the terriers, when they come out of the earth to take breath and cool themselves. It will also be necessary to put collars of bells about the necks of your terriers, which making a noise may cause the badger to bolt out. The tools used for digging out of the badger being troublesome to be carried on men's backs, may be brought in a cart. In digging, you must consider the situation of the ground, by which you may judge, where the chief angles are; for else, instead of advancing the work, you will hinder it. In this order you may besiege them in their holds, or castles, and may break their platforms, parapets, casemates, and work to them with mines and countermines, until you have overcome them.

Buck

BUCK-HUNTING. Here the ſame hounds and methods are uſed, as in running the ſtag; and, indeed, he that can hunt a hart or ſtag well, will not hunt a buck ill.

In order to facilitate the chace, the game-keeper commonly ſelects a fat buck out of the herd, which he ſhoots in order to maim him, and then he is run down by the hounds.

As to the method of hunting the buck: the company generally go out very early for the benefit of the morning. Sometimes they have a deer ready lodged, if not, the coverts are drawn till one is rouz'd; or ſometimes in a park a deer is pitched upon, and forced from the herd, then more hounds are laid on to run the chace: if you come to be at a fault, the old ſtaunch hounds are only to be relied upon till you recover him again: if he be ſunk and the hounds thruſt him up, it is called an imprime, and the company all ſound a recheat; when he is run down, every one ſtrives to get in to prevent his being torn by the hounds: fallow-deer ſeldom or never ſtanding at bay.

He that firſt gets in, cries *hoo-up*, to give notice that he is down and blows a death. When the company are all come in, they paunch him and reward the hounds; and generally the chief perſon of quality amongſt them *takes ſay*, that is, cuts his belly open, to ſee how fat he is. When this is done, every one has a chop at his neck, and the head being cut off is ſhewed to the hounds to encourage them to run only at male deer, which they ſee by the horns, and to teach them to bite only at the head: then the company all ſtanding in a ring, one blows a ſingle death, which being done all blow a double recheat, and ſo conclude the chace with a general halloo of hoo-up, and depart the field.

FOX-HUNTING makes a very pleaſant exerciſe, and is either above or below ground.

1. Above ground. To hunt a fox with hounds, you muſt draw about groves, thickets, and buſhes near villages. When you find one, it will be neceſſary to ſtop up his earth the night before you deſign to hunt, and that about midnight, at which time he is gone out to prey: this may be done, by laying two white ſticks a-croſs in his way, which he will imagine to be ſome gin or trap laid for him; or elſe, they may be ſtopped up with black thorns and earth mixed together.

At firſt, only caſt off your ſure finders, and as the drag mends, add more as you dare truſt them. The hound firſt caſt off ſhould be old and ſtaunch, and when you hear ſuch a hound call on merrily, you may caſt off ſome others to him; and when they run it on the full cry, caſt of the reſt: thus you ſhall complete your paſtime. The words o comfort are the ſame which are uſed in other chaces The hounds ſhould be left to kill the fox themſelves, and to worry and tear him as much as they pleaſe.

When he is dead, hang him at the end of a pike-ſtaff, and halloo in all your hounds to bay him; but reward them with nothing belonging to the fox, for it is not good, neither will the hounds in common eat it.

2. Under ground. If in caſe a fox does ſo far eſcape as to earth, countrymen muſt be got together with ſhovels, ſpades, mattocks, pick-axes, *&c.* to dig him out, if they think the earth not too great. They make their earths as near as they can in ground that is hard to dig, as in clay, ſtony ground, or amongſt the roots of trees; and their earths have commonly but one hole; and that is ſtrait a long way in before you come at their couch. Sometimes craftily they take poſſeſſion of a badger's old burrow, which hath a variety of chambers, holes, and angles.

Now to facilitate this way of *hunting the fox*: the huntſman muſt be provided with one or two terriers to put into the earth after him, that is to fix him into an angle; for the earth often conſiſts of many angles: the uſe of the terrier is to know where he lies, for as ſoon as he finds him he continues baying or barking, ſo that which way the noiſe is heard that way dig to him. Your terriers muſt be garniſhed with bells hung in collars, to make the fox bolt the ſooner; beſides the collars will be ſome ſmall defence to the terriers.

The inſtruments to dig withal are theſe; a ſharp pointed ſpade, which ſerves to begin the trench, where the ground is hardeſt, and broader tools will not ſo well enter; the round hollowed ſpade, which is uſeful to dig among roots, having very ſharp edges; the broad flat ſpade to dig withal, when the trench has been pretty well opened, and the ground ſofter; mattocks and pick-axes to dig in hard ground, where a ſpade will do but little ſerve; the coal-rake to cleanſe the hole, and to keep it from ſtopping up; clamps, wherewith you may take either fox or badger out alive to make ſport with afterwards. And it would be very convenient to have a pail of water to refreſh your terriers with, after they are come out of the earth to take breath.

After this manner you may beſiege a fox, *&c.* in their ſtrongeſt holes and caſtles, and may break their caſements, platforms, parapets, and work to them with mines and counter-mines till you have obtained what you deſired.

HARE-HUNTING. If it be rainy, the hare uſually takes to the high-ways; and if ſhe come to the

the ſide of a young grove, or ſpring, ſhe ſeldom enters, but ſquats down till the hounds have overſhot her; and then ſhe will return the very way ſhe came, for fear of the wet and dew that hangs on the boughs. In this caſe, the huntſman ought to ſtay an hundred paces before he comes to the wood-ſide, by which means he will perceive whether ſhe return as aforeſaid; which if ſhe do, he muſt halloo in his hounds, and call them back, and that preſently.

The next thing that is to be obſerved, is the place where the hare ſits, and upon what wind ſhe makes her form, either upon the north or ſouth wind; ſhe will not willingly run into the wind, but run upon a-ſide, or down the wind; but if ſhe form in the water, it is a ſign ſhe is foul and meaſled: if you hunt ſuch a one, have a ſpecial regard all the day to the brook-ſides, for there, and near plaſhes, ſhe will make all her croſſings, doublings, *&c.*

Some hares have been ſo crafty, that as ſoon as they have heard the ſound of a horn, they would inſtantly ſtart out of their form, though it was at the diſtance of a quarter of a mile, and go and ſwim in ſome pool, and reſt upon ſome ruſh bed in the midſt of it; and would not ſtir from thence till they have heard the horn again, and then have ſtarted out again, ſwimming to land, and have ſtood up before the hounds four hours, before they could kill them, ſwimming and uſing all ſubtilties and croſſings in the water. Nay, ſuch is the natural craft and ſubtilty of a hare, that ſometimes, after ſhe has been hunted three hours, ſhe will ſtart a-freſh hare, and ſquat in the ſame form. Others having been hunted a conſiderable time, will creep under the door of a ſheep-coat, and there hide themſelves among the ſheep; or when they have been hard hunted, will run in among a flock of ſheep, and will by no means be gotten out from among them, till the hounds are coupled up and the ſheep driven into their pens. Some of them (and that ſeems ſomewhat ſtrange) will take the ground like a coney, and that is called, *going to the vault.* Some hares will go up one ſide of the hedge, and come down the other, the thickneſs of the hedge being the only diſtance between the courſes. A hare that has been ſorely hunted, has got upon a quickſet hedge, and ran a good way upon the top thereof, and then leapt off upon the ground. And they will frequently betake themſelves to furz-buſhes, and will leap from one to the other, whereby the hounds are frequently in default.

Having found where a hare hath relieved in ſome paſture or corn-field, you muſt then conſider the ſeaſon of the year, and what weather it is; for if it be in the ſpring-time or ſummer, a hare will not then ſet in buſhes; becauſe they are frequently infeſted with piſmires, ſnakes, and adders; but will ſet in corn-fields, and open places. In the winter-time, they ſet near towns and villages, in tufts of thorns and brambles, eſpecially when the wind is northerly or ſoutherly. According to the ſeaſon and nature of the place where the hare is accuſtomed to ſit, there beat with your hounds, and ſtart her; which is much better ſport than trayling of her from her relief to her form.

After the hare has been ſtarted, and is on foot, then ſtep in where you ſaw her paſs, and halloo in your hounds, until they have all undertaken it, and go on with it in full cry; then recheat to them with your horn, following fair and ſoftly at firſt, making not too much noiſe either with horn or voice; for at the firſt, hounds are apt to overſhoot the chace thro' too much heat. But when they have run the ſpace of an hour, and you ſee the hounds are well in with it, and ſtick well upon it, then you may come in nearer with the hounds, becauſe by that time their heat will be cooled, and they will hunt more ſoberly. But, above all things, mark the firſt doubling, which muſt be your direction for the whole day; for all the doublings that ſhe ſhall make afterwards will be like the former, and according to the policies that you ſhall ſee her uſe, and the place where you hunt, you muſt make your compaſſes great or little, long or ſhort, to help the defaults, always ſeeking the moiſteſt and moſt commodious places for the hounds to ſcent in.

To conclude; thoſe who delight in hunting the hare, muſt riſe early, leſt they be deprived of the ſcent of her foot-ſteps.

HART *or* STAG-HUNTING. Firſt, encompaſs the beaſt in her own layer, and ſo unharbour her in the view of the dogs, that ſo you may never loſe her ſlot or footing. Neither muſt you ſet upon every one, either of the herd, or thoſe that wander ſolitary alone, or a little one, but partly by ſight, and partly by their footing and fumets, make a judgment of the game, and alſo obſerve the largeneſs of his layer.

The huntſman, having made theſe diſcoveries in order to the chace, takes off the couplings of the dogs, and ſome on horſeback, the others on foot, follow the cry, with the greateſt art, obſervation, and ſpeed, remembring and intercepting him in his ſubtile turnings and headings; with all agility leaping hedges, gates, pales, ditches; neither fearing thorns, down hills, nor woods, but mounting freſh horſe, if the firſt tire; follow the largeſt head of the whole herd, which muſt be ſingled out of the chace; which the dogs perceiving, muſt follow; not following any other. The dogs are animated to the ſport by the winding of horns, and the

the voices of the huntſmen. But ſometimes the crafty beaſt ſends forth his little ſquire to be ſacrificed to the dogs and hunters, inſtead of himſelf, lying cloſe the mean time. In this caſe, the huntſman muſt ſound a retreat, break off the dogs, and take them in, that is, leam them again, until they be brought to the fairer game; which riſeth with fear, yet ſtill ſtriveth by flight, until he be wearied and breathleſs. The nobles call the beaſt a *wiſe hart*, who, to avoid all his enemies, runneth into the greateſt herds, and ſo brings a cloud of error on the dogs, to obſtruct their farther purſuit; ſometimes alſo beating ſome of the herd into his footings, that ſo he may the more eaſily eſcape, by amuſing the dogs. Afterwards he betakes himſelf to his heels again, ſtill running with the wind, not only for the ſake of refreſhment, but alſo becauſe by that means he can the more eaſily hear the voice of his purſuers, whether they be far from him, or near to him. But at laſt being again diſcovered by the hunters and ſagacious ſcent of the dogs, he flies into the herds of cattle, as cows, ſheep, &c. leaping on a cow or ox, laying the fore parts of his body thereon, that ſo touching the earth only with his hinder feet, he may leave a very ſmall or no ſcent at all behind, for the hounds to diſcern.

But their uſual manner is, when they ſee themſelves hard beſet, and every way intercepted, to make force at their enemy with their horns, who firſt comes upon him, unleſs they be prevented by ſpear or ſword. When the beaſt is ſlain, the huntſman with his horn windeth the fall of the beaſt, and then the whole company comes up, blowing their horns in triumph for ſuch a conqueſt; among whom, the ſkilfulleſt opens the beaſt, rewards the hounds with what properly belongs to them, for their future encouragement; for which purpoſe the huntſmen dip bread in the ſkin and blood of the beaſt, to give to the hounds.

It is very dangerous to go in to a *Hart at bay*, of which there are two ſorts, one on land and the other in water. Now if the Hart be in a deep water, where you cannot well come at him, then couple up your dogs; for ſhould they continue long in the water, it would endanger their ſurbating or foundering. In this caſe, get a boat, and ſwim to him, with dagger drawn, or elſe with rope that has a nooſe, and throw it over his horns; for if the water be ſo deep that the Hart ſwims, their is no danger in approaching him; otherwiſe you muſt be very cautious.

As to a *land-bay*; if a *Hart* be burniſhed, then you muſt conſider the place; for if it be in a plain and open place, where there is no wood nor covert, it is dangerous and difficult to come in to him; but if he be on a hedge-ſide, or in a thicket, then, while the *Hart* is ſtaring on the Hounds, you may come ſoftly and covertly behind him, and cut his throat. If you miſs your aim, and the *hart* turn head upon you, then take refuge at ſome tree; and when the *hart* is at bay, couple up your hounds: and when you ſee the *hart* turn head to fly, gallop in, roundly to him, and kill him with your ſword.

Directions at the death of a HART *or* BUCK.

The firſt ceremony, when the huntſman comes in to the death of a deer, is to cry, *ware haunch*, that the hounds may not break in to the deer; which being done, the next is the cutting his throat, and there blooding the youngeſt hounds, that they may the better love a deer, and learn to leap at his throat: then the mort having been blown, and all the company come in, the beſt perſon, who hath not *taken ſay* before, is to take up the knife that the keeper or huntſman is to lay acroſs the belly of the deer, ſome holding by the fore-legs, and the keeper or huntſman drawing down the pizzle, the perſon who *takes ſay*, is to draw the edge of the knife leiſurely along the middle of the belly, beginning near the briſket, and drawing a little upon it, enough in the length and depth to diſcover how fat the deer is; then he that is to break up the deer, firſt ſlits the ſkin from the cutting of the throat downwards, making the arber, that ſo the ordure may not break forth, and then he paunches him, rewarding the hounds with it.

In the next place, he is to preſent the ſame perſon, who *took ſay*, with a drawn hanger, to cut off the head of the deer. Which being done, and the hounds rewarded, the concluding ceremony is, if it be a ſtag, to blow a tripple mort; and if a buck, a double one; and then all who have horns, blow a recheat in concert, and immediately a general whoop, whoop.

OTTER-HUNTING is performed with dogs, and alſo with a ſort of inſtruments, called *otter-ſpears*; with which, when they find themſelves wounded, they make to land, and fight with the dogs, and that moſt furiouſly, as if they were ſenſible that cold water would annoy their green wounds.

There is indeed craft to be uſed in hunting them; but they may be catched in ſnares under water, and by river-ſides; but great care muſt be taken, for they bite ſorely and venomouſly; and if they happen to remain long in the ſnare, they will get themſelves free by their teeth.

In hunting them, one man muſt be on one ſide of the river, and another on the other, both beating the banks with dogs; and the beaſt not being

able

able to endure the water long, you will ſoon diſcover, if there be an otter, or not, in that quarter; for he muſt come out to make his ſpraints, and in the night ſometimes to feed on graſs and herbs.

If any of the hounds finds out an otter, then view the ſoft grounds and moiſt places, to find out which way he bent his head; if you cannot diſcover this by the marks, you may partly perceive it by the ſpraints; and then follow the hounds, and lodge him as a hart or deer. But if you do not find him quickly, you may imagine he is gone to couch ſomewhere farther off from the river; for ſometimes they will go to feed a conſiderable way from the place of their reſt, chooſing rather to go up the river than down it. The perſons that go a hunting otters, muſt carry their ſpears, to watch his vents, that being the chief advantage; and if they perceive him ſwimming under water, they muſt endeavour to ſtrike him with their ſpears, and if they miſs, muſt purſue him with the hounds, which, if they be ſo good and perfectly entered, will go chanting and trailing along by the river-ſide, and will beat every root of a tree, and oſier-bed, and tuft of bull-ruſhes; nay, they will ſometimes take water, and bait the beaſt, like a ſpaniel, by which means he will hardly eſcape.

Roe-Buck-Hunting is performed divers ways, and very eaſily in the woods.

When chaſed, they uſually run againſt the wind, becauſe the coolneſs of the air refreſhes them in their courſe; therefore the huntſmen place their dogs with the wind: they uſually, when hunted, firſt take a large ring, and afterwards hunt the hounds. They are alſo often taken by counterfeiting their voice, which a ſkilful huntſman knows how to do by means of a leaf in his mouth. When they are hunted, they turn much and often, and come back upon the dogs directly; and when they can no longer endure, they take ſoil, as the hart does, and will hang by a bough in ſuch a manner, that nothing of them ſhall appear above the water but their ſnout, and they will ſuffer the dogs to come juſt upon them before they will ſtir.

The veniſon of a *roe-buck* is never out of ſeaſon, being never fat, and therefore they are hunted at any time; only that ſome favour ought to be ſhewn the *doe*, while ſhe is big with fawn, and afterwards till her fawn is able to ſhift for himſelf. He is not called, by the ſkilful in the art of hunting, a *great* roe-buck, but a *fair* roe-buck; the herd of them is called a bevy: and if he hath not bevy-greaſe upon his tail, when he is broken up, he is more fit to be dog's meat than man's meat.

The hounds muſt be rewarded with the bowels, the blood, and feet ſlit aſunder, and boiled all together.

From thoſe words of God to *Adam*, *Gen.* i. 26, 28. and to *Noah*, *Gen.* ix. 2, 3. *Hunting* was conſidered as a right devolved, or made over to man; and the following ages appear to have been of the ſame ſentiment. Accordingly we find that among the more civilized nations, as the *Perſians*, *Greeks*, and *Romans*, it made one of their genteeler diverſions; and as to the wilder and more barbarous, it ſerved them with food and neceſſaries. The *Roman Juriſprudence*, which was formed on the manners of the firſt ages, made a law of it, and eſtabliſhed it as a maxim, that as the natural right of things which have no maſter, belongs to the firſt profeſſor; wild beaſts, birds, and fiſhes, are the property of whoever can take them firſt. But the northern nations of *Barbarians* who overrun the *Roman* empire, bringing with them a ſtronger taſte for the diverſion; and the people being now poſſeſſed of other and more eaſy means of ſubſiſtence, from the lands and poſſeſſions of thoſe they had vanquiſhed; their chiefs and leaders began to appropriate the right of *Hunting*, and inſtead of a natural right, to make it a royal one. Thus it continues to this day; the right of *hunting* among us belonging only to the king, and thoſe who derive it from him.

HUSBANDRY.

IT would be very proper to introduce this treatiſe, with principles of vegetation: but that has been already done in the head of *Gardening*. We ſhall therefore begin with our remarks on *Tillage*.

Tillage is the art of dividing the particles of the natural earth to advantage, or to render it fruitful.

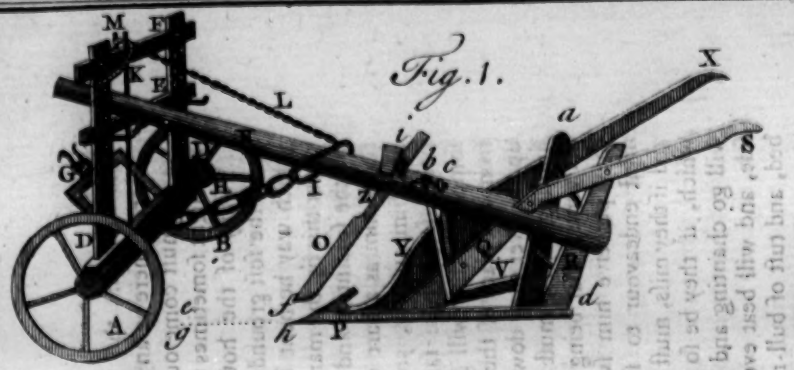
This diviſion is made either by fermentation, *i. e.* by mixing *dung* with the earth, or by breaking the native earth mechanically into parts with a ſpade, a plough, a hoe, or any other inſtrument invented for ſuch a purpoſe.

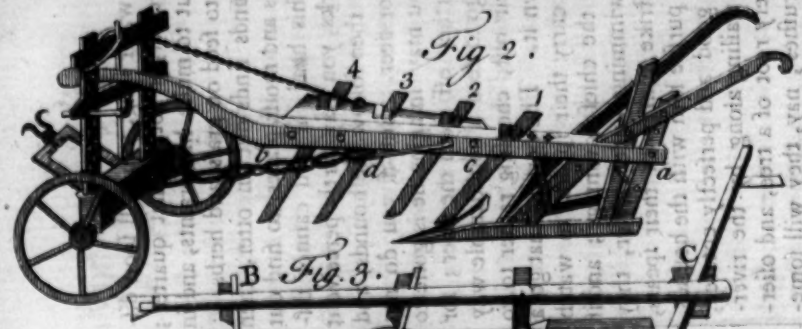
The moſt profitable method to increaſe the fruitfulneſs of land is, the laſt mentioned; not only, on account of the ſcarcity and price of *dung*, but becauſe the particles of earth may be divided and ſubdivided, *ad infinitum*.

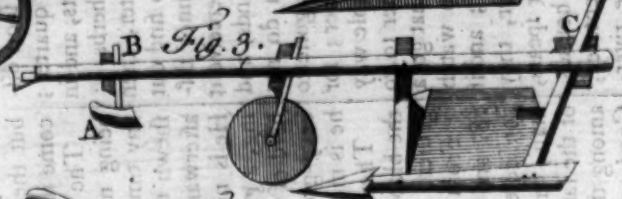
It is alſo worthy our attention, that no grain nor roots, nor pulſe ſown in land, manur'd with

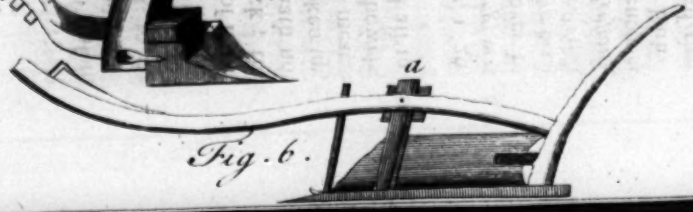
dung

Different KINDS of PLOUGS.



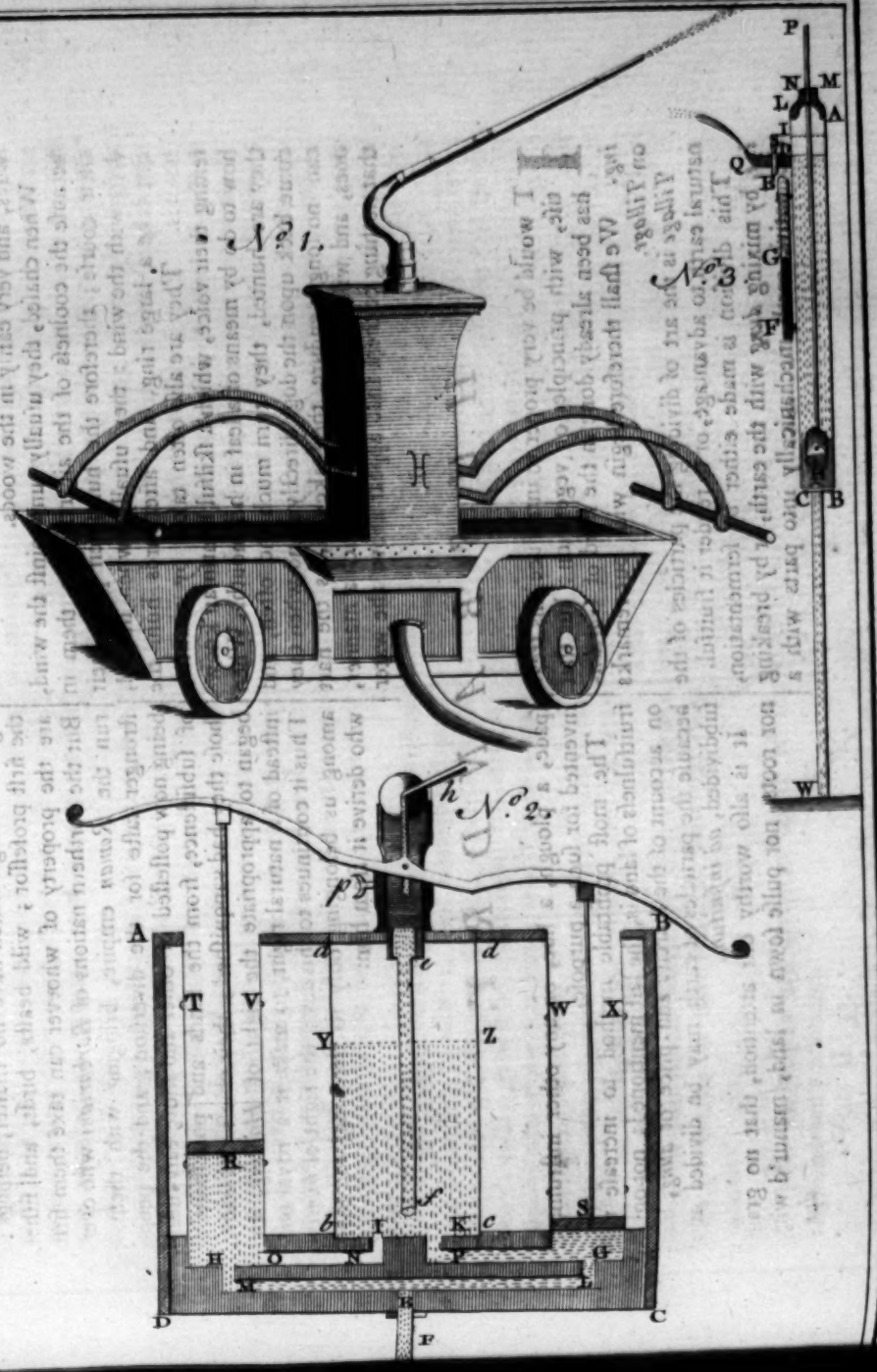


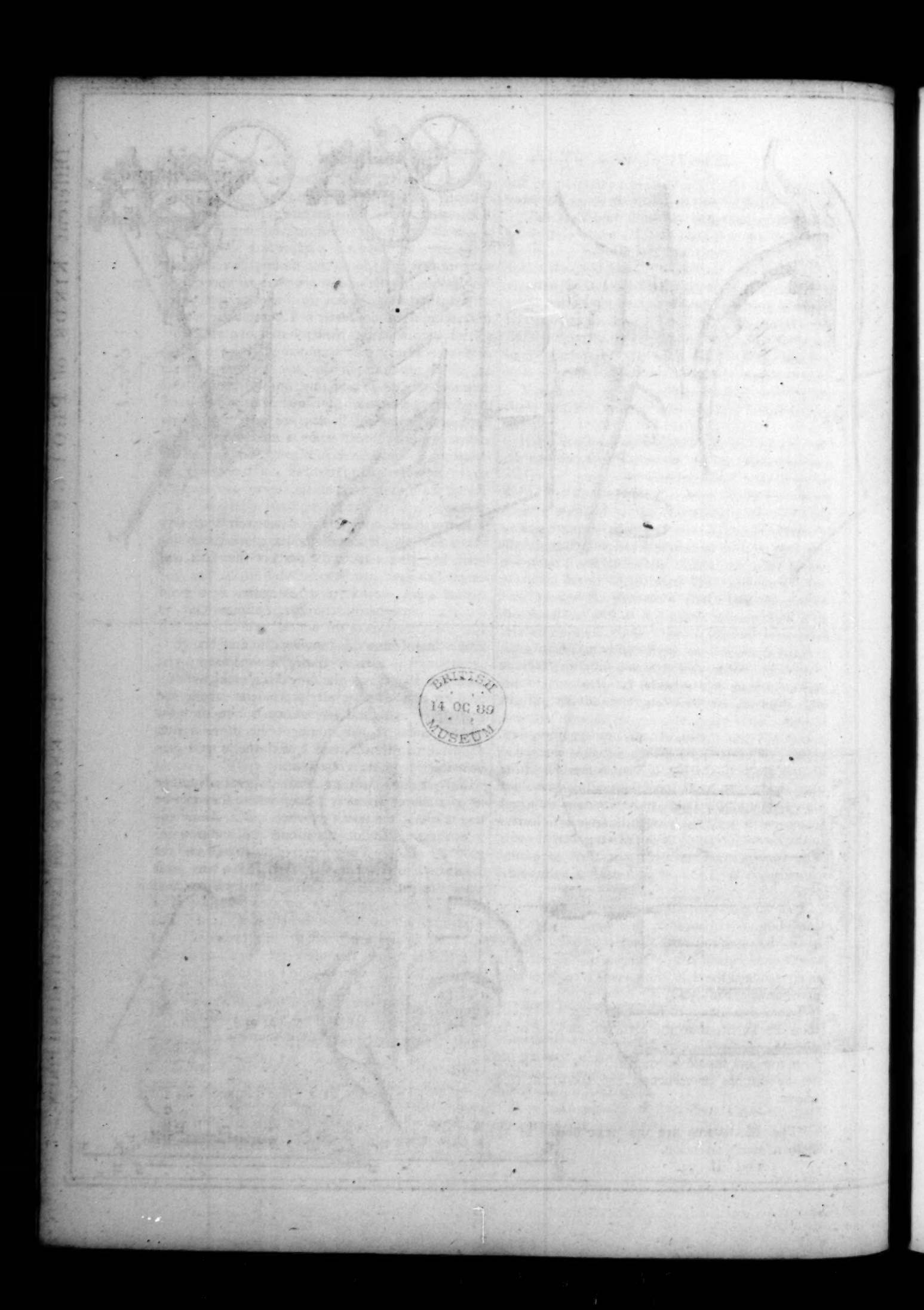




The ENGINE for EXTINGUISHING FIRES.

To face Husbandry

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dung, ever have the fine flavour as thoſe produced in a good ſoil, that has not been dung'd.

Beſides *dung* harbours inſects, which live upon, and deſtroy the plants and grain.

Not that *dung* ſhould be totally rejected. It is neceſſary in clay lands which have their parts ſo cloſe: it prevents the parts re-uniting after being divided by tillage: ſo that the roots can't penetrate them without great difficulty: and conſequently, they muſt languiſh for want of nouriſhment. And it is no leſs neceſſary for ſuch light lands, as contain but few nutritive parts.

Whenever *dung* is uſed in cultivating of land, prepare the dunghill in this manner. Sprinkle each layer of *dung* with quick-lime. This will kill the inſects, deſtroy the ſeeds of weeds, enrich the dung, and warm a cold earth.

Tho' dung be uſed, the huſbandman muſt not ſpare his labour in the tillage: on the contrary, he will find the moſt profit by multiplying the frequent plowings of the earth, and not be content with *rolling* and *harrowing*: for in very moiſt land, the roller will do it more hurt than good; and to ſcratch the earth with a harrow, is not only of little ſervice, but when it is moiſt, the horſes poach and damage it conſiderably.

If the ground to be broke up be *wood land*, the earth is ſo well broken into particles, by grubbing up the roots of the trees, that you need give it only one plowing in autumn, and another in the ſpring.

If it be covered with broom, heath, ruſhes, fern, buſhes, and briars, burn them towards the end of ſummer, when the plants are wither'd. Then grub up the ſtrongeſt roots with a pick-ax: and after the autumnal rains, plow the land into high ridges, with a ſtrong plough. Another plowing in the ſpring prepares it for ſowing it with oats. The ſecond year will require three thorough plowings, and it will be fit for wheat in the third year,

If it be paſture or meadow land to be tilled, one ploughing in autumn, and another in ſpring: if it be not too wet, fits it for oats. But it won't yield a good crop of wheat, till the earth be finely reduced for that grain, which requires more nouriſhment than oats.

Lands thus ploughed for eight or ten years ſhould then be burnt, that the particles may be better divided.

If the land ſhould be marſhy, drain off the water by ditches or trenches, and then treat it as above.

The MANURES are the next object of the huſbandman's attention.

CLAY, ſays Mr. *Evelyn*, p. 22, of his *Terra*, is of all other a curſt ſtep-dame to almoſt all vegetation, as having few or no *meatus's* for the percolation of the alimental ſhowers, or expanſion of the roots; whether it be the voracious, hungry, weeping, or cold ſort. In theſe caſes *laxatives* are to be preſcribed, ſuch as drift *ſand*, ſmall *gritty gravel*, *ſaw-duſt*, with *marle* or *chalk*, and continually vexing it with the ſpade or plow; but above all, with *ſea-ſand*, where it may be procured, and the burning of the ground to *aſhes*, and all that it bears, the more the better; for by no leſs ſeverity will this ill-natur'd mould be ſubdued: *rotten wood*, and the bottom of bavine ſtacks, are good ingredients to this manure; and if it be a cold and wet ſort, ſtrewings of *ſoot* are good; if very ſtiff, rubbiſh of *brick*, *lime-ſtone*, and ſuch traſh, may properly be laid at the bottom, and on the upper part *compoſts* of *dung*.

Rotten-wood, and *ſaw-duſt* when rotted, ſays Mr. *Miller* too, is a very good manure for ſtrong lands, becauſe it looſens the parts of the earth, and renders it light.

Mr. *Liſle*, Vol. I. p. 26. adviſes, as a good way, to tame harſh, churliſh, obſtinate clay, to fling it up in ridges in the winter, and after the firſt froſt, when it thaws and molders, to fling and temper amongſt it *aſhes* or *chalk*, or whatſoever you have to qualify it: for the time being nickt, wherein you can catch the clayey corpuſcles under the greateſt diſunion and ſeparation, is the time for keeping them ſo, by mixing theſe other lighter bodies amongſt them, which will the longeſt prevent them from their re-union.

Sea-ſand and *ſhells* are uſed to great advantage as a manure, in many places where they can be had without too much expence. Mr. *Miller* adviſes them chiefly for cold ſtrong land, and *loam* inclining to *clay*. They ſeparate the parts; and the ſalts which are contained in them, are a very great improvement of land. Coral, and ſuch kind of ſtony plants which grow on the rocks, are filled with ſalts which are very beneficial to land. But as theſe bodies are hard, the improvement is not the firſt or ſecond year after they are laid on the ground, becauſe they require time to be pulveriſed before their ſalts can mix with the earth to impregnate it. The conſequence of this is, that their manure is laſting. *Sand*, and the ſmaller kinds of *ſea-weeds*, will inrich land for ſix or ſeven years; and *ſhells*, *corals*, and other hard bodies, will continue many years longer.

In ſome countries, at a great diſtance from the ſea, great quantities of foſſil-ſhells have been diſcovered, and uſed with ſucceſs as manure: but they are not near ſo full of ſalts, as thoſe ſhells which

are taken from the ſea-ſhore; and therefore the latter are always to be preferred.

Sea-ſand is much uſed as manure in *Cornwall*, ſays Mr. *Borlace* in his *Natural Hiſtory of that county*. The beſt is that which is intimately mixed with coral. In places where this excellent manure is found, it is taken up by a large bag of the ſtrongeſt canvas, to the mouth of which is fitted an iron hoop or frame for keeping it open, and ſinking it to the bottom of the ſea, ſo as it may receive the ſand and coral as it is dredged along by the bargemen. A barge-load is uſually delivered for ten ſhillings, or leſs if near the place of dredging: and where the land is good, a barge-load will dreſs an acre. It is uſed more for corn, than paſture grounds. It gives the heat of lime, and the fatneſs of oil, to the land it is laid upon. Being more ſolid than ſhells, it conveys a greater quantity of fermenting earth in equal ſpace. Beſides, it does not diſſolve in the ground ſo ſoon as ſhells, but decaying more gradually, continues longer to impart its warmth to the juices of the earth. It is chiefly found in *Falmouth* harbour, and the ſhores adjoining. Not only *ſea-ſand* is uſed as manure by every one who has it in his reach, but after ſtorms they find the *alga marina*, *fucus conſerva*, or ore-weed, one of the beſt manures which nature affords, ſcattered in great plenty on the ſhore. Being a ſub-marine plant, the wind and ſun ſoon exhale its moiſture: the ſooner therefore it is taken from the ſhore, the better; and being ſpread on old and ſtiff earth, then covered with ſand, it ſoon diſſolves into a ſalt oily ſlime.

This is the moſt approved way of applying it. Some lay it naked and freſh from the ſea, upon their barley lands, in the end of *March* and beginning of *April*, and have a good crop of corn: but the weeds grow ſo plentifully and rank afterwards, that no wholſome graſs for paſture is to be expected for that year. Sir *George M'Kenzie* obſerves (*Phil. Tranſ.* No. 117.) that lands often uſed to this manure yield bad oats, and in a ſmall quantity, the huſks thicker than ordinary, and more darnel among the corn, than in lands which have not ſo much ore-weed laid upon them.

The uſe of *ſand*, as Mr. *Miller* obſerves, is to make the clayey earth fertile, and fit to feed vegetables, &c. for earth alone, we find, is liable to coaleſce, and gather into a hard coherent maſs, as is apparent in clay; and earth thus embodied, and, as it were, glued together, is no ways diſpoſed to nouriſh vegetables: but if with ſuch earth, ſand, &c. *i. e.* hard cryſtals, which are not diſſolvable in water, and ſtill retain their figure, be intermixed, they will keep the pores of the earth open, and the earth itſelf looſe and incompact, and by that means give room for the juices to aſcend, and for plants to be nouriſhed thereby.

Thus, a vegetable, planted either in ſand alone, or in a fat glebe, or earth alone, receives no growth or increment at all, but is either ſtarved or ſuffocated: but mix the two, and the maſs becomes fertile. In effect, by means of ſand, the earth is rendered, in ſome manner, organical; pores and interſtices being hereby maintained, ſomething analogous to veſſels, by which the juices may be conveyed, prepared, digeſted, circulated, and at length excerned, and thrown off into the roots of plants.

Sea-ſand, continues Mr. *Miller*, is accounted a very good compoſt for ſtiff ground, for it effects the two things following, *viz.* It makes way for the tree or ſeed to root in ſtiff ground, and makes a fume to feed it.

Chalk, lime, rubbiſh of old houſes, or, in ſhort, whatever looſens the body of the *clay*, are good manures.

Shell-Marle, or any *marle*, which, dropt into vinegar, makes a ſtrong efferveſcence, is a peculiarly good manure for *clay*: for, diſſolving eaſily in water, it gives a freer paſſage to it, whereby the *clay* is kept dry even in winter; and if the *clay* is of a cold acid quality, the abſorbent quality of the *marle* deſtroys that acidity, and keeps the *clay* warm. Many late experiments prove the truth of this, its effects being much beyond what could have been expected.

In very cold moiſt land, ſays Mr. *Miller*, I have frequently ſeen new *horſe-dung* buried as it came from the ſtable, and always obſerved that the crops have ſucceeded better, than where the ground was dreſſed with very rotten dung.

Sheep's dung and *deers dung* are nearly of the ſame quality, and are eſteemed by ſome the beſt of dungs for cold clays. Some recommend beating them into powder, and ſpreading them very thin over autumn or ſpring crops, about four or five loads to an acre, in the ſame manner that *aſhes*, *malt-duſt*, &c. are ſtrewed. But theſe light dreſſings do not laſt long.

In *Flanders*, and other parts, they houſe their *ſheep* at nights in places ſpread with clean ſand, laid about five or ſix inches thick; which, being laid on freſh every night, is clear'd out once a week. This mixture of *ſand* and *dung*, makes an excellent dreſſing for ſtrong land; for the *dung* and *urine* of the *ſheep* is a very rich manure. Mr. *Quinteny* thinks it the greateſt promoter of fruitfulneſs in all ſorts of ground. Others recommend *hogs dung*, as the fatteſt and moſt beneficial of any.

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The *dung* of *pigeons* and *poultry* is eſpecially good for cold, wet, clayey lands: but it ought to be dried before it be ſtrewed, becauſe it is naturally apt to clod in wet; and it ſhould be mixed with earth or ſand to keep it from clogging together, that it may be ſtrewed thin, being naturally very hot and ſtrong.

Human dung is another great improver of all cold ſour lands, and eſpecially if it be mixed with other earths or dungs to give it a fermentation.

But there is not any ſort of manure equal to the cleanſing of the ſtreets of great cities, for all ſtubborn clayey ſoils, the parts of which will be better ſeparated, and in a much leſs time, with this manure, than with any other compoſt whatſoever.

SAND. By the ſame rule that *ſand* fertiliſes ſtrong clayey grounds, *clay* meliorates light and ſandy ſoils. But this manure can never have its due effect, unleſs it be well broken, and divided into ſuch ſmall particles as to be able to incorporate thoroughly with the light earth.

Arenous and ſandy earth, ſays Mr. *Evelyn*, p. 19. wants ligature; and beſides, conſiſting of ſharp and aſperous angles, wounds and galls, curls and dwarfs our plants, without extraordinary help, to render the paſſages more ſlippery and eaſy: and therefore relenting *chalks*, or *chalk-marle*, is profitable, with *calcinations* of *turf*, or *ſea-wrack*, where it is at hand: and if the ſoil be exceeding bibulous, ſpread a layer or couch of *loam*, diſcreetly mingled at the bottom, to entertain the moiſture. — *Sand*, being of an open and looſe contexture, is apt to put forth a forward ſpring, as more eaſily admitting the ſolar rays: but it does not continue, and is an infirmity which may be remedied with *loam*, which not only unites it cloſer for the preſent, but is capable in time to alter and change its very nature alſo, ſo as too hot a *compoſt* be no ingredient with it. — If the ſoil be *ſandy*, or other light mixed earth, imbody it with ſomething of a fatter nature, as *marle*; and be ſure ſo to ſtir and lay it (eſpecially if with *loam*) that it may not ſink too deep, and ſuddenly, as 'tis apt to do, and ſo deſert the ſurface-mould, where it ſhould do the feat, and therefore it is to be the oftner repeated.

Dr. *Liſter* divides the *Engliſh* ſands into two claſſes: the firſt, ſharp or red ſand, conſiſting of ſmall tranſparent pebbles, naturally found on the mountains, and not calcinable: the ſecond, ſoft or ſmooth.

Mr. *Miller* obſerves, that grounds which are ſandy and gravelly, eaſily admit both of heat and moiſture; but then they are liable to theſe inconveniences, that they let them paſs too ſoon, and ſo contract no ligature, or elſe retain them too long, eſpecially where there is a clay bottom; and by that means they are either parched or chilled too much, and produce nothing but moſs and cankerous infirmities; but if the ſand happens to have a ſurface of good mould, and a bottom of gravel or looſe ſtone, though it do not hold the water, it may produce a forward ſweet graſs; and though it may be ſubject to burn, yet it quickly recovers with the leaſt rain.

Sand indeed is apt to puſh the plants that grow upon it, early in the ſpring, and make them germinate near a month ſooner than thoſe that grow upon *clay*; becauſe the ſalts in the ſand are at full liberty to be raiſed and put into motion, upon the leaſt approach of the warmth of the ſun: but then, as they are haſty, they are ſoon exhaled and loſt.

Clay is another excellent manure, ſays the author of the *New Syſtem of Huſbandry*, p. 124. and eaſy enough to be found in all places: but you muſt obſerve, 'tis only uſeful upon *ſandy* grounds, or any lands of a nature entirely different from its own; among which you may reckon *gravelly* or *pebbly* ſoils. To theſe it brings the only part of excellence they naturally want, and conſequently changes them, from what they were originally, to an equal fertility with the beſt and richeſt.

This will, perhaps, be ſtrange news to many countrymen, who have bought *dung*, all their lifetime, to deſtroy their land with. 'Tis as great a folly, adds our author, to *dung* grounds which require *cooling*, as 'twould be thought to adminiſter *poiſon*, to cure a man of a *fever*. Our farmers are not ſenſible, that the *temper* of the *land* muſt, as neceſſarily, be conſulted, as the *pulſe* of the *patient*. The dunghill only is their univerſal refuge; they fly to *that* upon all occaſions. They miſs a crop, by dunging an improper ſoil; and lay on more dung to remedy the misfortune.

The practice of the *North-Riding* of *Yorkſhire*, as related by Dr. *Liſter*, *Phil. Tranſact.* N°. 225. ſhews to how great advantage *clay* is made uſe of there, as a manure. The *clay* is of a bluiſh colour, not ſandy at all, but very ponderous. They dry it about *Midſummer*, on the declivity of a hill, and lay 100 loads on an acre of ground of a light ſandy ſoil. They obſerve, that for three or four years it continues yet in clods upon the land; and that the firſt year, the land ſo manured bears rank ill-coloured and broad-grain'd barley, but afterwards a plump round corn like wheat. This clay manuring will, by certain experience, laſt above forty years in the ground, and then it muſt be clayed again. This ſandy ground, unleſs clayed, will bear nothing but rye, whatever other manure they uſe.

Clay becomes a much better manure when mixed with *lime*, than perhaps either of them are singly. The *lime* corrects the bad qualities of the *clay*, by rendering it more friable.

Sea-ouſe, that is, the ſettling of the tides on ſhores, and level places, between low and high-water mark, is a manure of incomparable excellence for many ſorts of lands; but is, on others, to be avoided, as a certain bane to whatever part 'tis mixed with. Looſe ſandy ſoils are peculiarly benefited by it.'

The cleaning of ponds and ditches becomes likewiſe here an excellent manure, conſiſting of the putrified animal and vegetable bodies mixed with the rich earth depoſited there by rains, *&c.* The ſame may be ſaid of the mud in rivers, where, by the ſtagnating, or want of current in the water, the rich particles carried down by it have time to ſubſide.

But of all the manures for ſandy ſoils, none is ſo good as *marle*. There are many different kinds and colours of it, ſeverally diſtinguiſhed by many writers; but their virtue is the ſame; and they may all be uſed upon the ſame ground, without the ſmalleſt difference in their effect.

The colour is, either *red*, *brown*, *yellow*, *blue*, *gray*, or *mix'd*. It is to be known by its pure and uncompounded nature. There are many marks to diſtinguiſh it by; ſuch as its breaking into little ſquare bits; its falling eaſily to pieces, by the force of a blow, or upon being expoſed to the ſun, and the froſt; its feeling fat and oily, and ſhining when 'tis dry.—But the moſt unerring way to judge of *marle*, and know it from any other ſubſtance, which may appear like it, is, to break a piece as big as a large nutmeg, and, when 'tis quite dry, drop it to the bottom of a glaſs of clear water, where, if it be right, it will diſſolve and crumble, as it were to duſt, in a very little time, ſhooting up many ſparkles to the ſurface of the water.

Loam, being free from the too great ſtiffneſs of *clay*, and the too little coheſion of *ſand*, in order to its due culture, ſeems only to ſtand in need of being kept in good tilth, and ſupplied at proper ſeaſons with ſuch ſubſtances as the experience of ages has ſhewn to contain in them matter fit for the nouriſhment of plants, or at leaſt to be endued with the power of rendering the earth fruitful. Such ſubſtances we ſhall therefore call *general manures*. Of theſe, dungs of all kinds, putrid, vegetable and animal ſubſtances, aſhes of vegetables, and even of ſea-coal and peat, ſoot, and lime, are the chief.

Dungs, as Mr. *Miller* obſerves, are deſigned to repair the decays of exhauſted worn out lands, and to cure the defects of land, which are as various in their qualities as the dungs are, that are uſed to meliorate and reſtore them. Some lands abound too much in coldneſs, moiſture, and heavineſs; others again are too light and dry; and ſo, to anſwer this, ſome dungs are hot and light, as that of ſheep, horſes, pigeons, *&c.* others again are fat and cooling, as that of oxen, cows, hogs, *&c.* And as the remedies that are to be uſed, muſt be contrary to the diſtempers they are to cure; ſo the dung of oxen, cows, and hogs, muſt be given to lean, dry, light earths, to make them fatter and cloſer; and hot and dry dungs to meliorate cold, moiſt, and heavy lands.

There are, continues he, two peculiar properties in *dung*: the one is to produce a certain ſenſible heat, capable of producing ſome conſiderable effect, which properties are ſeldom found but in the *dung* of horſes and mules, while it is newly made, and a little moiſt: the other property of *dung* is, to fatten the earth, and render it more fruitful.

The *dung* of horſes and mules is an admirable fertilizer: but care muſt be taken not to lay too much of it on corn lands, becauſe it produces abundance of ſtraw.

Horſe *dung*, being of a very hot nature, is beſt for cold lands, and cow dung for hot lands; and being mixed together, may make a very good manure for moſt ſorts of ſoils, and for ſome they may be mixed with earth.

The *dung* of pigeons and fowls is ſo rich, that it is generally uſed for a dreſſing to plants whilſt they are growing. That of pigeons, ſays Mr. *Miller*, is the beſt ſuperficial improvement that can be laid on meadow or corn land: but before it is uſed, it ought to have lain abroad out of the dove-houſe ſome time, that the air may have a little ſweetened it, and mollified the fiery heat that is in theſe *dungs*.

The *dung* of poultry being hot and full of ſalts, tends much to facilitate vegetation: and is abundantly quicker in its operation, than the *dung* of animals which feed on herbs.

To animal ſubſtances belong all parts of their bodies, as fleſh, blood, ſhavings of bones, hoofs, rags of their wooll or hair, *&c.*

Mr. *Evelyn* ſays, the blood and fleſh of animals is much more powerful for the enriching of land, than their dung and excrements, and is computed at twenty times the advantage; and to the ſame advance above this, is hair and calcined bones. Woollen rags are peculiarly uſed for light ſoils. They ſhould be chopt ſmall, about an inch or two ſquare, and ſcattered on the earth at the ſecond plowing; for being thereby covered, they will begin to rot by ſeed-time. They imbibe the moiſture

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of dews and rain, and retain it long; and, as Dr. *Home* obſerves, thereby keep light ſoils in a moiſt ſtate. The ſame may be ſaid of the hoofs of cattle, when ſet upright in the earth, as Mr. *Ellis* directs. They hold the rain that drops into them, and it putrifies there, till, being worked out by ſucceeding ſhowers, it falls upon the ſurrounding earth, and communicates a great fertility to it.—Sea-ſhells may likewiſe be included under this head: but we have already ſpoken of them, in the article *clay*.

Vegetables afford great abundance of excellent manure. The cuſtom of plowing in green ſucculent plants, is very antient. All the *Roman* authors ſpeak of it particularly. Buck wheat and vetches are the two plants moſt frequently ſown in *England* for that purpoſe; and the time of plowing them in, is when they are in bloom, being then in their moſt ſucculent ſtate. Some farmers plow in their ſecond crop of clover, to enrich the land for wheat in the autumn. This ſhould be done early enough to give the plants ſufficient time to putrify thoroughly before the grain is ſowed: otherwiſe it might prove prejudicial, by bringing on a heat which would hurt the corn. Sea-weeds of all ſorts are a moſt profitable manure to be plowed in.

Rotten vegetables of moſt ſorts, ſays Mr *Miller*, greatly enrich land: ſo that, where other manure is ſcarce, theſe may be uſed with great ſucceſs. The weeds of ponds, lakes, or ditches, being dragged out before they ſeed, and laid on heaps to rot, will make excellent manure; as will moſt other ſorts of weeds. But wherever any of theſe are employed, they ſhould be cut down as ſoon as they begin to flower: for if they are ſuffered to ſtand untill their ſeeds are ripe, the land will be ſtored with weeds, which cannot be deſtroyed in two or three years; nay, ſome kind of weeds, if they are permitted to ſtand ſo long as to form their ſeed, will perfect them after they are cut down, which may be equally prejudicial to the land: therefore the ſureſt way is to cut them down juſt as they begin to flower; at which time moſt ſorts of vegetables are in their greateſt vigour, being then ſtronger and fuller of juice, than when their ſeeds are farther advanced: ſo that at that time they abound moſt with ſalts, and therefore are more proper for the intended purpoſe. In rotting theſe vegetables, it will be proper to mix ſome earth, mud, or any other ſuch like ſubſtances with them, to prevent their taking fire in their fermentation; which they are very ſubject to, when they are laid in large heaps, without any other mixture to prevent it: and it will be proper to cover the heaps over with earth, mud, or dung, to detain the ſalts; otherwiſe many of the finer particles will evaporate in fermenting. When theſe vegetables are thoroughly rotted, they will form a ſolid maſs, which will cut like butter, and be very full of oil, which will greatly enrich the land.

Another manure, greatly, and very properly recommended by this gentleman, is rotten tanner's bark. Oak-bark, ſays he, after the tanners have uſed it for tanning of leather, when laid in a heap, and rotted, is an excellent manure, eſpecially for ſtiff cold land; in which one load of this manure will improve the ground more, and laſt longer, than two loads of the richeſt dungs. It is better for cold ſtrong land, than for light hot ground, becauſe it is of a warm nature, and will looſen and ſeparate the earth; ſo that where this manure has been uſed three or four times, it hath made the land very looſe, which before was ſtrong, and not eaſy to be wrought. When this manure is laid on graſs, it ſhould be done ſoon after *Michaelmas*, that the winter rains may waſh it into the ground: for if it is laid on in the ſpring, it will burn the graſs, and, inſtead of improving it, will greatly injure it for that ſeaſon. Where it is uſed for corn land, it ſhould be ſpread on the ſurface before the laſt plowing, that it may be turned down for the fibres of the corn to reach it in the ſpring; for if it lies too near the ſurface, it will forward the growth of corn in winter; but in the ſpring, when the nouriſhment is chiefly wanted to encourage the ſtem, it will be nearly conſumed, and the corn will receive little advantage from it.

Aſhes of all green vegetables contain an alkaline ſalt, of great uſe as a manure, but eaſily diſſolved in water, and carried off. Greater care ſhould therefore be taken to keep ſuch aſhes covered from the air, till uſed.

Peat-aſhes are likewiſe of great ſervice. We ſhall here give Mr. *Ellis*'s account of this manure in his own words, vol. II. p. 68. "If barley, ſays he, is ſown ſo late as the beginning of *May*, lean peat-aſhes in particular may be applied over it, or harrowed in with the grain: but aſhes burnt from fat black peat, ſuch as they dig at *Newbury*, are of ſuch a ſulphurous nature, that they are afraid to lay them on their barley; and they do not dreſs their wheat with them till the ſpring is advanced, and then they are ſown over it.—The great uſe of theſe aſhes was found out about thirty (now fifty) years ago: but in a little time after they were brought into diſreputation, by their imprudently laying on too many at a time, which burnt up the corn. Afterwards they found that ſix or ten buſhels were ſufficient to be ſown over an acre of wheat, peaſe, turneps, clover, rape-ſeed, or St. Foyne, as early as they conveniently could. But,

as I ſaid before, they are afraid to ſow it over barley, leſt a dry time ſhould enſue, and burn it up; for theſe aſhes are reckoned to contain three times as much ſulphur in them, as there is in coal aſhes; and this they reaſonably imagine from their great brimſtone ſmell, ſparkling and jumping, when they are ſtirred as they are burning, and drying up the corn by their too great heat. Theſe peat-aſhes, and likewiſe thoſe from wood or coal, will help to keep off the ſlug from peaſe and other grains, by the ſalt and ſulphur contained in them, and very much conduce to their preſervation in cold wet ſeaſons. But there is no ſuch danger to be feared from the aſhes of that peat, which grows as a turf over ſandy bottoms, as great quantities do on *Leighton-heath*, in *Bedfordſhire*; for theſe are as much too lean, as the others are too rank."

Soot, either of vegetables or of coal, is reckon'd a good improver of cold and moiſt grounds. Many find their account in ſtrewing it early over their green wheat and barley: but Mr. *Ellis* ſays, neither of them ought by any means to be ſooted after the 25th of *April*, becauſe the wheat, and generally the barley, have then done gathering and branching, and are upon the ſpindle. He thinks it likewiſe proper to be ſown over young turneps, that have all juſt appeared. Care ſhould be taken not to ſtrew it too thick; for otherwiſe its hot nature might hurt the plants.

Malt-duſt is a good manure for poor clayey lands; and will oftentimes go farther than dung. It is moſt beneficial when rain falls upon it ſoon after its being ſtrewed, and waſhes it into the earth before it has loſt its ſtrength. In ſome parts of *Berkſhire*, they lay the *malt-duſt* on at the ſame time that they ſow the wheat, and harrow them both in together. This they find turn to good account. Some huſbandmen hold it to be better for ſummer corn, than for wheat, and the reaſon they aſſign is, that the winter corn lies a whole year in the ground, and the *malt-duſt* will have ſpent its ſtrength by the time the winter is over, and not hold up the corn in heart all the ſummer. They ſow with the wheat two quarters of *malt-duſt* to an acre, which makes four quarters of corn meaſure.

This manure is likewiſe a great improvement to cold graſs grounds.

All ſorts of fern, ſtraw, brake, ſtubble, ruſhes, thiſtles, leaves of trees, or any manner of vegetable traſh whatever, ſays Mr. *Worlidge*, either caſt into the yards amongſt the cattle or ſwine, or caſt into pools or places to rot in, or mixed with other ſoils, help very much, and make very good compoſt. The lees of wine and the grounds and ſettlings of beer, ale, *&c.* have the ſame effect.

Chalk is a laſting manure for lands that it agrees with. *Pliny* tells us it was the cuſtom of the *Britons* to chalk their lands, by which, ſays he, they received a great improvement, which laſted their lives.

It is a general ſaying, that chalking is better for the father than the ſon; but experience often ſhews it to be as good an improvement as *dung*, for twenty years together: and that clay land has been always the better for it.

There are ſeveral ſorts of *chalk*: ſome of ſo hard and indiſſoluble a nature, that it is not fit to lay on lands ſimply as it is, but after it is burnt into *lime*, it becomes an excellent improver. Other ſorts of *chalk*, more unctuous and ſoluble, being laid on lands crude as they are, and let lie till the froſts and rain ſhatter and diſſolve them, prove a very conſiderable advantage to barren lands.—Where any of theſe *chalks* are found, Mr. *Worlidge* adviſes proving their natures, by laying them on ſome ſmall portion of land, crude as they are, or by burning them into *lime*, if fewel be plenty, or to half-burn them; by which, ſays he, you may experimentally know the true effects and benefits that ſubject will yield.—And although, continues he, *chalk*, ſimply of itſelf, either burnt or unburnt, may not prove ſo advantageous as many have reported, yet it is of very great uſe to be mixed with earth and the dungs of animals, by which may be made an admirable, ſure, and natural fruitful compoſition for almoſt any ſort of lands, and raiſeth corn in abundance.

Chalk ought never to be plowed in, either too ſoon or too deep. It ſhould have time to crack and waſte on the ſurface of the earth, and not be turned down to the bottom of the furrow, leſt it ſhould ſubſide there in a maſs, and not be ſtirred by ſubſequent plowings. Twelve or fourteen loads upon an acre will make ſome lands produce extraordinary crops of corn for fourteen or fifteen years together.—In the *Iſle of Wight*, they ſometimes lay twenty-five waggon-loads of it on an acre. Their *chalk* is of a fat ſoapy kind, and they call it *marle*. The farmers in the hundreds of *Eſſex* bring their *chalk* as far as from *Graveſend*, but lay not half ſo much on an acre, as thoſe of the *Iſle of Wight*.—It ſhould always be ſpread as ſoon as poſſible after it is dug, becauſe it is apt to harden and grow ſtoney in the air.

Mr. *Worlidge* ſays, you may deal with chalky land as with clay land, though in a moderate way: for chalky land is naturally cold, and therefore requires warm applications. It is alſo ſad, and will therefore the better bear with light compoſts; which is the reaſon that *chalk* is ſo great an improver of light, hot, and dry grounds, eſpecially after it has ſuffered a calcination.

If *chalk* be laid on *clay*, ſays Mr. *Liſle*, vol. I. p. 66. it will in time be loſt, and the ground again return to its *clay*: and if *clay* be laid on *chalk*, in time the *clay* will be loſt, and the ground return again to its chalky ſubſtance. Many people, continues he, think the land on which the other is laid for a manure, being predominant, converts the manure into its own ſoil: but I conceive in both caſes the *clay* and *chalk* is, in time, filtrated through the land on which 'tis laid, and being ſoluble by rain into ſmall corpuſcles, is waſhed thro' the land on which 'tis laid; for neither of theſe manures is able to unite in its fineſt corpuſcles, with the corpuſcles of the land on which it is laid, ſo as to make ſo ſtrict an union and texture with it as the land doth with itſelf, and is therefore liable to be borne downwards with rains, till no ſign of it be left.

Chalk, laid upon meadows, will enable them to give a great crop for three or four years, but it is thought afterwards to impoveriſh them. — Mr. *Liſle* is of opinion, that the contrary is the caſe with reſpect to paſture lands: becauſe the graſs being thereby greatly ſweetened and increaſed, keeps conſtantly ſo much the more ſtock, by which it is maintained always in the ſame vigour.

The ſame gentleman aſſigns the following reaſons, why chalk is good for ſandy and clayey ſoils. I do ſuppoſe, ſays he, that *chalk*, laid on ſandy or wood-ſeary ground laid up for paſture, may waſh and ſink in, and fill up the interſtices, and thereby conſolidate and mend the texture of ſuch ground, and ſweeten it, as it is a great alkali: and tho' by time moſt of the *chalk* may be waſhed downwards, ſo that the ground may loſe the virtue, yet I do ſuppoſe the ſtrength of the ground may ſtill continue much the better, by reaſon that ſuch manure having made the ſword of the graſs come thicker and ſweeter, the good paſturage on both accounts enlarges the quantity, and betters the quality of the dung the cattle leave on it, which in return maintains a better coat and ſurface to the ground: and as *chalk* fills up the vacuities of ſandy or wood-ſeary ground, ſo on the contrary, it inſinuates its particles into obſtinate clayey and ſtrong land, and divides it, by making in a manner a ſciſſure, thereby hollowing and mellowing it; ſo that the two contrary extreams are cured by *chalk*.

As *loam* may be inclined either to *clay* or *ſand*, the huſbandman may collect his manure accordingly, either of dry opening ingredients, ſuch as *aſhes*, *lime*, *dung* of *ſheep* and *horſes*, rubbiſh of old houſes, *&c.* for the former; or of things which give coheſion and fatneſs, ſuch as *dung* of *cows* and *hogs*, putrid, animal and vegetable ſubſtances, marle, *&c.* for the latter.

Our farmers, collecting the manures they find neceſſary from time to time, as they come to hand, generally heap them together in what they call dung-hills. Theſe dung-hills ſhould be placed where there are no running waters or ſprings, that their rich juices may not be waſhed away. They are greatly negligent in this care. Mr. *Evelyn*, and the author of the *New Syſtem of Agriculture*, call theſe aggregates of compoſts *ſtercoraries*. Such ſhould by no means have a communication with any of the offices, as adviſed by the latter; for the vapours ariſing from the putrid dung, muſt prove hurtful to the health of horſes or other cattle expoſed to it in a confined place. Mr. *Evelyn* diſapproves of laying dung in heaps in the field, expoſed to the ſun, rain, and drying winds, whereby all its ſpirit and ſtrength is carried away; and adviſes the following, as a better method of managing our dung-hills, or *ſtercoraries*.—Let the bottom or ſides of a pit, ſays he, be about four feet deep, paved with ſmall chalk or clay at the bottom, that it may hold water like a ciſtern: direct your channels and gutters about your houſe and ſtables to it. The pit muſt be under covert, ſo that the down-right rains may not fall into it. Lay a bed of dung in it a foot thick, on that a bed of fine mould, on that another bed of cyder-mere, rotten fruit, and garden offal, on this a couch of pigeons and poultry dung, with more litter, and beds of all variety of ſoil, and upon all this caſt water plentifully from time to time.

The directions of the author of the *New Syſtem of Agriculture*, for making a *ſtercorary*, and which we much approve of, barring its being ſo near the ſtable as he ſeems to intend it, are as follow.

Along the back of your ſtable cauſe a pit to be dug, to the depth of the foundation, or a pretty deal below it: let it be as long as the ſtable, but its breath ſhould be according to the quantity of dung you have conveniencies for making: let this pit be arched with brick, but very ſlightly, and an entrance left at one end, which may be ſhut up, or opened, by a wooden door: let the ſides and bottom be firmly lined with ſtone, and cloſely plaiſtered over with a cement, which will by no means admit moiſture.

Through the wall of this ſtable, and about a foot or more from the ground, let there be made ſquare holes, which, opening into the *ſtercorary*, from within the ſtable, muſt be of ſufficient largeneſs for the paſſage of the dung, that is, from time to time, to be ſhovell'd through them.

The ſtable floor ſhould be made as ſmooth and hard as poſſible, that the urine of the horſes may not ſoak into it, but deſcending from them to a little gutter, cloſe along the wall, thence run through

through paſſages, which are purpoſely to be made, into the *ſtercorary*.

Pipes of earth, which coſt but little, ſhould be laid, from this place to the cow-houſe, hog-ſties, and privies, that all urine of man or beaſt, of any kind whatſoever, may immediately be convey'd to mingle with the other. Into which muſt be caſt all ox dung, cow dung, hogs dung, and dung of fowls; all aſhes, whether of wood, or ſea-coal; the duſt and ſweepings of your yard and houſe; all weeds, old litter, rotten ſtraw, and ſpare earth, which you can get; as alſo the waſhing of barrels, all ſoap-ſuds, water which meat has been boil'd in, diſh-water, and every ſuch kind of thing, which is now thrown down the common ſink, and render'd uſeleſs: and for the more convenient performance of all this, there may be left a pretty large ſquare hole, in the outward declivity of the arch which covers the *ſtercorary*. This hole muſt have a wooden door fitted to it, which, lifting up and down, will, as occaſion offers, not only ſerve for taking in the things above-named, but, whenever more moiſture may be thought wanting, it will admit as much as is convenient, by being left open in rainy weather, and, as ſoon as ſhut, forbid the entrance of any more. The other door, which I ſpoke of, in one of the ends, is only to ſerve for carrying out the dung, when it is to be made uſe of.

In ſuch a *ſtercorary* as is here deſcribed, the charge is a trifle, not worth naming, in compariſon with the profit. The dungs and other things, incorporating, and fermenting thus together, mellowed, and enriched by the ſpirit of the urine, and unimpaired by the ſun, rain, or wind, attain an excellence, which is beſt known by the prodigious increaſe they make in your crops; and which demonſtratively proves, that one load thus managed, is of more effect than twenty after the common manner.

We leave to experience to determine, whether a *ſtercorary* with only a ſhade thrown over it, would not nearly anſwer all the ends propoſed by cloſing it up, and have none of the dangers attending the other.

The method of making *lime* is ſufficiently known. It's uſe and application, as a manure, is all that appertains to our ſubject.

Liming of land, ſays the author of the *Engliſh Improver*, is of moſt excellent uſe; many barren parts of this kingdom being thereby brought to ſo fertile a condition for bearing moſt ſorts of grain, that as good wheat, barley, and peaſe, as *England* yields, has, with the help of that manure properly diſtributed, been raiſed upon land, before not worth above a ſhilling or two an acre. He adds, that twelve or fourteen quarters will lime an acre. Another writer ſays 160 buſhels. The difference of the land may require a different proportion.

The moſt natural land for lime, ſays Mr. *Worlidge*, is the light and ſandy; the next, mixt and gravelly: wet and cold gravel is not good, and cold clay is the worſt of all.

A mixture of *lime*, *earth*, and *dung*, together, adds he, is a very excellent compoſt for land.

Mr. *Evelyn* adviſes, for lands that want heat, to mix *lime* with *turf* and *ſwarth*, laying them alternatively, turf on lime, and lime on turf, in heaps, for ſix months, by which means it will become ſo mellow, and rich in nitrous ſalts, as to diſſolve and run like aſhes, and carry a much more cheriſhing vigour, than if uſed alone in a greater quantity, and without danger of burning out and exhauſting the vegetative virtue which it ſhould preſerve.

Lime, a little ſlack'd, continues he, is excellent for cold wet grounds and ſtiff clays, but it overburns drier ſoils. It is the very deſtroyer of moſs and ruſhes, as quick-lime is of furzes, being firſt extirpated.

Mr. *Liſle* thinks it is beſt, eſpecially in lands that work mellow, to ſpread and plow the lime in, as ſoon as it is ſlacked, rather than to let it lie long covered with the earth in heaps.

Chalk-lime is not, in his opinion, ſo beneficial to land, as *ſtone-lime*; becauſe a greater virtue muſt be attributed to the *ſtone-lime* for its burning quality after it is laid on.

Lime, being laid on meadows or paſtures, ſlacks and cools by ſlow degrees, ſo as not to undergo ſuch a heat and fermentation, as when it is covered with the hillocks of earth flung up in arable; therefore, ſays he, it cannot be of that great advantage to paſture.

The lighter the land is, the more *lime* it will require: the ſtronger, the leſs. In ſome places they lay twenty-four or thirty quarters on an acre. The nature of the ſoil muſt determine the proper quantity.

In *Leiceſterſhire* they ſow or ſcatter the *lime* on wheat land when they ſow the wheat, but on barley land the laſt earth but one; and ſo plow it in, leſt, if they ſhould ſow it with the barley in the ſpring, it might burn it. They lay five quarters to an acre of each, according to the meaſure as it comes from the kiln, for after it is ſlack'd thoſe five quarters will make near ten.

As the intent of liming land, is to bind it, Mr. *Liſle* thinks it ſhould not be limed late in the year, becauſe the land being then cold and moiſt, and but a weak ſun to conſolidate it, the deſign of liming is fruſtrated; for if it does not conſolidate at firſt liming, it will not afterwards.

In

In *Shropſhire* they lay dung and lime together, *viz.* about twenty load of dung, and only twenty buſhels of lime on an acre.

Mr. *Liſle* gives it as a rule to all huſbandmen, to be cautious of liming ground, and then plowing out the heart of it. I limed, ſays he, ſome years ago, in *Wiltſhire*, ſeven acres for an experiment, and laid down one acre to its own natural graſs in two years time, the graſs of which is to this day 40 ſhillings an acre. The third year I laid down another acre, which is to this day worth 30 ſhillings per acre. The reſt I plowed five or ſix years farther, which is not worth fifteen groats per acre. The like experience, adds he, I have had in burn-beaking ground.

Burning, or, as ſome call it, *burn-beaking* of land, may be reckoned among manures, becauſe it is a very great improvement, and only practiſed upon ſome old paſture, or heathy, ruſhy, broomy, and ſuch like barren grounds, which are conſiderably enriched by it; though, as the author of the *New Syſtem of Agriculture* juſtly remarks, lands ſo improved are, for want of one obſervation, generally ruined, in the common practice of plowing them three or four crops ſucceſſively; by which means their whole fertility is moſt aſſuredly exhauſted, and the ſoil becomes incapable of vegetation, though aſſiſted by the richeſt dung, or other manure, in the world. Nothing but ten or fifteen years repoſe, will reſtore the abuſed vigour of nature; whereas, were theſe grounds ſtrengthened by a little *marle*, *chalk*, or *dung*, between their firſt harveſt and their ſecond ſeeding, the improvement would be made compleat and laſting. No method would be more eaſy; nothing poſſibly more advantageous.

The manner of burning land is generally known to be a paring off the fibrous turf, to a conſiderable depth, in a hot ſeaſon, which being made into little hills, rais'd hollow, and at equal diſtances, are ſet on fire, as ſoon as they are dry enough to kindle, and ſo burnt to a kind of red aſhes, and thoſe aſhes ſcartered over the whole ſurface: the ground is then plowed up very ſhallow, and the ſeed immediately ſown.

This burning of ground is very coſtly, and not a little tedious, becauſe the turf is raiſed in a laborious manner, by the force of a man's arms and boſom, puſhing againſt a thing they call a *breaſt-plow*. —I will preſent you, continues our author, with a much neater invention, and which ſaves, at leaſt, two thirds of the charge.

Let ſome ſmith in your neighbourhood, who is a ready workman, make a hollow plow-ſhare, of a double form, that is, one which riſes with a ſharp edge in the middle, from the point to the top, and has a *fin* both ways; which fins muſt alſo begin at the point, and ſo run back to the ſhare end. The dimenſions of this ſhare will be two feet broad, from the extreme points of the fins behind; one foot long, and a foot high, ſomewhat like a three-edg'd ſword, if it were cut off a little above the point. The three fins, or edges, muſt be very well ſteel'd, and the whole made as thin, and as ſmooth, as you can get it done. — Into the hollow of this ſhare muſt be faſtened a light ſtrong piece of aſh, ſharpened *forward*, to fit the boſom of the ſhare, but *behind*, as ſquare and ſturdy as may be. Into this laſt part muſt be fix'd a ſtrong piece of wood, like a *lever*; not perpendicular, but ſomewhat hanging backward. It muſt be about two feet high; and on the upper end, ſhould have a croſs ſtaff, or other contrivance, to which muſt be faſtened the harneſs of ſuch cattle as your team conſiſts of. The handles of the plow, and the *earth-boards* to turn the turf, are alſo fix'd into this ſquare head; and there is no other inſtruction neceſſary for the uſe of this plow, but that, when you begin upon the edge of a field, and turn one turf to the hedge, and the other to the field, the laſt will cover one of the breadths you muſt take at your coming back, and the point of your ſhare muſt, therefore, run cloſe along the edge of this length of turf; by which means one ſide of your plough will raiſe two lengths, and, throwing back the higheſt, lay that uppermoſt, which had before lain under. By this one obſervation, you cannot miſs the manner of plowing.

But, as this would only raiſe a long unwieldly *rope* of turf, which it would be neceſſary to cut into many hundred pieces, before it would be fit for *piling*, you will find the following invention of admirable uſe and expedition.

Chuſe the body of a ſhort thick tree; the heavier, and more ſolid, the better: let it be neatly rounded, and work'd into a *roller*, like thoſe that are uſed for leveling *barley lands*. This roller muſt be hoop'd round, in ſix ſeveral places, each two foot diſtant from another: the hoops muſt be of ſtrong iron, and nail'd very firmly on. — The middle part of every one of theſe hoops muſt riſe into an edge, to about five or ſix inches above the level of the hoop itſelf: theſe edges muſt be very ſharp, ſtrong, and well ſteel'd, that the weight of the roller, as it goes round, may not fail to preſs them all into the earth, as deep as they can go, and yet not damage them, either by blunting, bending, or breaking.

One horſe will very well draw this roller, with which you muſt go over the ground you intend to burn, the contrary or croſs way to that which you deſign to take with your plow, before deſcribed;

which will by this means turn up the turf in pieces of two foot long, and one broad, the exact ſize they ought to be to form the little hills above named. — I have nothing to add upon this head, but, that thoſe who practiſe it had need be careful how they *over-burn* the turf, which would, in that caſe, be robb'd of much of its fertility. A gentle fire, not flaming out, but mouldering inward, is the ſureſt means of hitting the perfection of this work.

In like manner Mr. *Worlidge* cautions us againſt over-burning the turf; and the reaſon is, that, in the burning of any vegetable, a gentle, eaſy, and ſmothering fire, does not waſte the volatile nitrous ſpirit ſo much as a quick fire would do, and cauſes more of it to fix and remain behind.

Moſſy grounds are peculiarly benefited by being burnt. Where much long *moſs* grows thick, ſays Mr. *Liſle*, tho' the ground be never ſo ſandy in its nature, yet the ground underneath muſt be of a moſt cold and ſour nature, by being kept from the ſun, and the wet more ſogging in it than if it had been ſolid earth upon it; for nothing retains moiſture longer than ſuch a ſpungy body, nor breaks the rays of the ſun more from penetrating. Therefore ſuch ground ought to be burn-beak'd; or the moſs harrow'd up before ſeeding, and burnt in heaps: but rather burn-beak'd, to deſtroy the ſeeds of weeds.

PLOWING. The *ſtrong* plough is to be uſed on all hard clays, ſtiff binding ſoils, and ſtony grounds, or any lands of that nature. — It is drawn by two oxen, nor are any more at any time neceſſary. — The following is his deſcription of it.

Let the length of your ſhare be a foot and a half; the point indifferently ſharp, but very ſtrong: let the ſhelving ſide be work'd thick, and without a *fin*, but ſteel'd all along its edge, from the point to the hinder part, where its perpendicular height muſt not exceed ſix inches. — The breadth muſt be juſt ſufficient to carry a furrow ſeven or eight inches broad. In this plough, the place of the breaſt-board muſt be ſupplied by an iron plate, which, joining to the ſhare, and being part of it, is, in a bellying manner, carried back, and gradually brought to *wheln*, as if it would fall upon the furrow. This plate, being made as thin as its uſe will permit, is ſupported by a pin from the plough-head, which is, in all reſpects, the ſame with that of the plough I before recommended, for paring up the turf of lands to be burnt. — This breaſt-iron, with all the neatneſs and facility imaginable, takes the earth, as it riſes on the ſhare, and, without labouring under the load of a long furrow, turns it over as it runs along, and neither toils the oxen nor the driver.

One man is enough in all reaſon to manage this plough. He guides his oxen by a goad, as uſual; and holds the handles with a great deal leſs fatigue than in other ploughs, for they are to be ſet at a large ſlope, and their ends ſtanding wide from each other, they have the greater power over the going of the plough. If the ſhare is apt to *bite*, or run too deep into the ground, his leaning a little harder than ordinary, on the handles, will raiſe the point to what pitch he pleaſes; as, on the contrary, when he lays no ſtreſs upon them, the team will of courſe draw the point downward.

The *light* plough is properly to be uſed on ſandy mellow grounds, and all ſuch as are directly oppoſite to thoſe for which the *ſtrong* plough is recommended. It is drawn by two horſes, with no manner of difficulty; or with one, if you pleaſe, for many have tried it.

The ſhare of this plough, is, in a manner, the ſhare of the *turfing-plough*, divided into two equal parts. The ſhare of the *light* plough ſhelves only one way, as not being double, and has a *breaſt-iron* exactly like that of the *ſtrong* plough. In all other reſpects, it is the very ſame with the *turfing-plough*, even in dimenſions, and therefore needs no farther deſcription.

One man will hold and drive this plough, with more eaſe than the ſtrong one, becauſe the loads are more manageable. The reins, whereby he turns and checks the horſes, paſs through two long ſlits, in each handle one, and being juſt of length enough to hang down five inches, or more, are prevented from being drawn back through the ſlits, by two pieces of wood, to which their extreme ends are faſtened.

Let us ſuppoſe then, that at *Lady-day* you begin your huſbandry, and that the quantity of land you are about to break up, is an hundred acres. The firſt thing neceſſary is, carefully and judiciouſly to obſerve both the *ſurface* of your ground, and the *depth* of it. If you find it a good deep mould, and covered by a thick, ſtrong, fibrous turf, ſuch as by long lying, is become firmly rooted; in this caſe it will be much the wiſeſt way to *burn* and ſpread the aſhes, by the rules before given, not, by any means, omitting to manure, between the firſt *reaping* and the ſecond *ſowing*; after which you may proceed in all points, as if the turf had been plow'd in, inſtead of being burnt.

But if, on the contrary, you find your upper mould ſhallow, or thin turf'd, it will by no means be proper to burn it: you muſt, therefore, take notice, whether your ſoil be of the *light* kind or the *heavy*. If, upon examining it by the marks above-mentioned, you find it of a *heavy* nature, you muſt prepare your *ſtrong* plough and ox team,

and

and take care that, in the firſt breaking up, as they call it, your plowman turns the turf ſide neatly downwards, and lays his furrows ſo ſmooth and cloſe together, that, at a little diſtance, a man can ſcarce ſee where the plow went. An acre and a half may eaſily be plow'd in one day, by the uſe of this plough; ſo that, beginning by the firſt of *April*, and allowing for *Sundays* and accidental hinderances, the hundred acres will be all broke up by the middle of *June* at fartheſt.

Between this firſt plowing and the ſecond, is the only proper time for laying on your *manure* of what kind ſoever. The ſeveral ſorts proper for lands of this nature, are *ſea-ſand*, *common-ſand*, *ſea-owſe* of the lighteſt kind, not ſuch as is black and greaſy; *ſheep's dung*, mix'd with *ſand* under a cover'd fold, as before deſcribed; or, for want of any of theſe, the *compoſt* in your *ſtercorary*.

Which ever of theſe you lie moſt convenient for, you may make uſe of, in the following proportions: of *ſea-ſand* you muſt lay upon every acre five and twenty loads; of *common-ſand* never leſs than a hundred, which quantity you may double, if it lies commodiouſly: twenty load of *ſea-auſe* is ſufficient; and fifteen of *ſheep's dung* ſo mingled: and if you are obliged to rely upon the aſſiſtance of your *ſtercorary*, you muſt lay about twenty load upon an acre.

According to the manure you are obliged to uſe, your charge will be more or leſs conſiderable in the number of carts and teams neceſſary: for this rule you muſt be ſure to obſerve punctually, that the *manure* be all laid on by the laſt day of *July*; in which time, the plowman, a labourer being employed to ſpread the manure, as it is daily brought on, does, with the ſame plough he uſed before, give the ſecond ſtirring to the ground, in order to turn in the richneſs of thoſe helps you have beſtowed upon it. By this means the ſun, high and powerful in this ſeaſon, will be prevented from exhaling the *virtue* of your manure, as it always does in the common way of letting it lie in little heaps in the field for a great while together.

You may obſerve, that, I allow a ſhorter time for *this* plowing, than for the *firſt*; and the reaſon is, becauſe the ground having been broken up before, and the turf now rotten, it is become more mellow, and the draught ſo much eaſier, that a team may diſpatch almoſt a double quantity in a day.

It is now the time to harrow over your ground, with a heavy wide-tooth'd harrow, and a great weight laid upon it; by which means more mould will be rais'd, the clods broken into ſmaller pieces, and the manure mingled with the ſoil in every part. It is not enough to harrow once and away;—you muſt go over the ſame ground again and again, till you have made it as ſmooth and crumbly as is requiſite; and this work will very well employ your team, from the end of *July*, to the middle of *Auguſt*: about which time ſhould be begun the third and laſt plowing.

I come now to your lands of a *light* temper, and, for method's ſake, will begin at *Lady-day* upon this land alſo. Here the *light* plough is to be uſed; and as to the turning down the turf, and laying ſmooth the furrows, the ſame care is to be obſerved on one land, which is recommended on the other. Of this work, two horſes, with the plough above-mentioned, will conſtantly break up two acres a day; and beginning with *April*, and allowing, as before, for *Sundays*, *&c.* the hnndred acres will be very well plowed, for the firſt time, by the latter end of *May*.

Betwixt the *firſt* arature and the *ſecond*, theſe lands are alſo to receive the annual recruits which you think fit to give them; and that may be either *chalk*, *marle*, *clay*, *ſheep's-dung*, prepared with *earth*, not *ſand*; *ſea owſe* of the cloſeſt, black, fat kind; all ſorts of *mud*, or, for want of either of theſe, your *ſtercorary* may ſupply you.

Five and twenty load of the laſt is the quantity moſt proper; thirty of chalk; of marle, at leaſt a hundred; and of clay, a little more. Twenty load of prepared ſheep's-dung, and as much of ſea-owſe; and if you uſe mud, leſs than forty or fifty load will be too little. Uſe either of theſe manures as your beſt conveniency invites you, and, as was directed before, take care that your plowman turns it in as faſt as it is brought on, and ſpread upon the ſurface.

But here comes a neceſſary caution, that your men begin to bring on the manure on that end of your hundred acres which your plowman firſt began to break up, that the turf may be rotted before it is turned up the ſecond time.—Be regardful of this rule, or you will find the neglect of it produce a great deal of confuſion.

When the manure is all turned in, bring on your heavy harrows, and go over the land ſo often, as till the whole maſs is exquiſitely mingled, and the mould becomes fine and duſty. You muſt be doubly careful in this operation upon your *light* lands, which ought by the harrow to be laid as ſmooth and level as a table.

About the beginning of *Auguſt* will come on your *ſeed plowing*, properly ſo called upon theſe *light* lands, becauſe you muſt here *plow* and *ſow* together.

Mr. *Tull* recommends putting all the horſes length-ways, when a ſoft ground is plowed; that, by their treading all in the furrow, the earth may be leſs poached.

If the land is in good tilth, it may be plowed in dry weather: but the beſt time is when it has been a little moiſten'd by rain, eſpecially for the new plough, which would not eaſily go deep, if the earth was very dry.

'Tis true that as the four-coulter'd plough enters deep, and turns up a great deal of earth, a greater ſtrength is required to draw it; ſo that it will be neceſſary to uſe three horſes inſtead of two, and four inſtead of three. But the excellence of this tillage will make ample amends for that additional expence.

The four-coulter'd plough is uſed only for the firſt plowings, to break up freſh grounds, or give a good tilth to thoſe that have not been plowed before, or that have been ill plowed for a long time. It is likewiſe very fit for winter plowings; and I think Mr. *Tull* uſes it ſometimes to make deep furrows in the middle of the alleys between the rows of corn.

The Seeds of all plants ſhould not be ſown at the ſame depth. To ſatisfy myſelf of this, I dug a trench twelve feet long, ſloping it gradually from the ſurface at one end, to the depth of two feet at the other. I ſowed different ſeeds in this trench; and having put the earth in its place, I obſerved 1. That hardly any ſeeds riſe when buried deeper than nine inches: 2. That ſome ſeeds riſe extremely well at the depth of ſix inches: 3. That other ſeeds do not riſe at all when they are above one or two inches deep. Experience ſhews that the ſame ſeeds may be buried deeper in a light, that a heavier ſoil; and that ſeeds which lie too deep in the earth to ſpring up in a dry year, may riſe in a warm moiſt year. Experience likewiſe teaches, that ſeeds which are buried too deep in the earth, will remain there ten or twenty years ſound and unaltered; ſo that if by moving that earth they chance to be brought to the ſurface, they grow extremely well, and produce their proper plant.

Mr. *Worlidge*'s opinion of Mildews, which he holds to be quite different things from *blights*, is, that they are cauſed from the condenſation of a fat and moiſt exhalation in a hot dry ſummer, from the bloſſoms and vegetables of the earth, and alſo from the earth itſelf, which, by the coolneſs and ſerenity of the air in the night, or in the upper ſerene region of the air, is condenſed into a fat glutinous matter, and falls to the earth again; part whereof reſts on the leaves of the oak, and ſome other trees whoſe leaves are ſmooth, and do not eaſily admit the moiſture into them, as the elm or other rougher leaves do; which *mildew* becomes the principal food of the induſtrious bees, being of itſelf ſweet, and eaſily convertible into honey.

Other part thereof reſts on the ears and ſtalks of wheat, beſpotting them with a different colour from what is natural; and, being of a glutinous ſubſtance, by the heat of the ſun, doth ſo bind up the young, tender, and cloſe ears of the wheat, that it prevents the growth and compleating of the imperfect grain therein; which occaſioneth it to be very light in the harveſt, and yield a poor and lean grain in the heap.

But if after this *mildew* falls, a ſhower ſucceeds, or the wind blow ſtiffly, it waſheth or ſhaketh it off, and are the only natural remedies againſt this ſometimes heavy curſe.

Some adviſe in the morning, after the *mildew* is fallen, and before the riſing of the ſun, that two men go at ſome convenient diſtance in the furrows, holding a cord ſtretch'd ſtrait between them, carrying it ſo that it may ſhake off the dew from the tops of the corn, before the heat of the ſun hath thickened it.

The ſowing of wheat early hath been eſteemed, and doubtleſs is the beſt remedy againſt *mildews*, by which means the wheat will be well filled in the ear before they fall, and your increaſe will be much more. For curioſity ſake, wheat was ſown in all the months of the year: that ſown in *July* produced ſuch an increaſe as is almoſt incredible. In *France*, they uſually ſow before *Michaelmas*.

Bearded-wheat is not ſo ſubject to *mildews* as the other, the fibres keeping the dew from the ear.

Whatever weakens the plant, brings the *ſmut*; for ſeed-corn which has been pricked or run thro' with a needle, or which is not fully ripe, and that which produces lateral or ſecond ears, is ſubject to the ſmut. As a proof that whatever weakens plants, cauſes the ſmut, he obſerves, that it is a frequent cuſtom with them to cut rye as ſoon as it ſpindles, for food for their cattle; and that this rye generally produces other ears, which ſeldom contain any but diſtemper'd grain.

Mr. *Tull* tells us that the cure of this diſtemper was firſt found out by an accident, which he relates thus.

"Brining of wheat, to cure or prevent ſmuttineſs (as I have been credibly informed) was accidentally diſcovered about ſeventy years ago, in the following manner, viz. A ſhip-load of wheat was ſunk near *Briſtol*, in autumn, and afterwards at ebbs all taken up, after it had been ſoaked in ſea-water; but it being unfit for making bread, a farmer ſowed ſome of it in a field; and when it was found to grow very well, the whole cargo was

bought

bought at a low price by many farmers, and all of it ſown in different places. At the following harveſt, all the wheat in *England* happened to be ſmutty; except the produce of this brined ſeed, and that was all clean from ſmuttineſs."

We ſhall here copy the directions given by the author of the *New Syſtem of Agriculture*, for the choice and preparation of ſeed-corn.

Let your corn be brought into the corner of a large barn floor, or great boarded hall, ſuch as few country houſes are without: order a man, with a broad wooden ſhovel, to throw the corn, with all his force, towards the oppoſite corner of the barn, or hall: the laſt is generally the fitteſt for it. In this exerciſe, all light, ſmall, ſhrivell'd grain, and the ſeeds of cockle, darnel, and other weeds, not being ſo heavy as the ſolid corn, will fall ſhort, and lie neareſt to the man who throws them; while ſuch as are large, plump, and weighty, out-flying all the reſt, are ſeparated widely, and may eaſily be gathered in what quantity you pleaſe. Experience only is capable of making men believe the wonderful advantages of ſowing ſeed thus choſen.

Take your corn, when it has been thus obtained, and throw it, by a buſhel at a time, into a large veſſel full of water: let a man ſtir it with a ſtaff, as violently as he can, for a conſiderable while together, and then, giving it a little time to ſettle, ſkim off all that ſwims upon the ſurface; and repeat this labour till no more riſes: after which, take out the corn which is ſunk to the bottom, and lay it by for ſeed; proceeding in the ſame manner, till you have your intended quantity.

Now make a *brine*, by throwing *bay-ſalt* into *rain-water*, till it becomes of ſtrength enough to bear an egg. In this liquor ſteep your *ſeed corn* for thirty hours: leſs time will have no manner of effect. Obſerve this, and regard not the contrary opinions of any men, let them pretend to never ſo much ſkill.

When you take your corn out of this brine, ſpread it upon a ſmooth floor, and, ſcattering upon it good ſtore of the *fine-ground powder of ſlack'd lime*, ſweep it up and down, and mingle it with the corn, till every grain leaves clinging to another, and becomes, as it were, *candied* with the lime: and in this condition let it be ſowed, never entertaining a moment's doubt of the infallible increaſe of your harveſt.

PLANTS that grow in any ground, different from thoſe which are intended to be cultivated in it, are called *weeds*.

They exhauſt the earth, as much as the moſt uſeful plants: nay, they ſometimes get the aſcendant, and multiply to ſo great a degree, that a field will almoſt ſeem never to have been ſowed with corn.

The weeds which are feared moſt, are, 1. *Cockle* or *darnel*. Its ſeed is black; but being heavy, and nearly of the ſame ſize as the grains of wheat, it is not eaſily ſeparated from them. Sifting, and throwing the corn at a diſtance on a large floor, are the beſt ways of clearing the wheat of it. If ground with the corn, it makes bread look black.

2. *Fox-tail*, the ſeed of which is ſomewhat like wheat. This gives bread a bitter taſte.

3 *Wild-poppy*, or *red-weed*, the ſeed of which is very ſmall, and ſometimes multiplies ſo prodigiouſly that it choaks the wheat.

4. *Wild-vetch*, which covers the corn when it is laid, hinders it from riſing again, and makes it rot.

5. *Dog's graſs*, and *colt's foot*, which multiply by their ſeeds, and extend themſelves by their creeping roots, and even by the pieces of their roots which are broke off by the plough.

6. *Melilot*, which gives bread a bad taſte; and,

7. *Thiſtles*, and many other weeds which greatly exhauſt the earth.

8. *Charlock*, the young plants of which it will be of advantage to the farmer to be able to diſtinguiſh from young turneps, eſpecially in weeding the latter, leſt they be reared or plucked up indiſcriminately. This can ſcarcely be done but by the taſte, the charlock being hot and bitter, and the turnep mild.

To prevent the increaſe of weeds, it is proper to deſtroy them before their ſeed is ripe.

The ſureſt way to deſtroy weeds, is, to continue plowing whilſt the corn grows: but this can be done only in the new huſbandry.

Weeds may be diſtinguiſhed into four kinds: 1. Into ſuch as have creeping perennial roots. 2. Such as grow in cold wet ſoils. 3. Such as are of a large ſucculent body; and 4. Such as having ſmall ſeeds, or that ripening before the corn, ſow themſelves. Each of theſe require different methods, to deſtroy them.

The firſt can only be deſtroyed by repeated ſummer fallows, by which their roots are cut, and turned up to be withered by the ſun and winds; after which they are dragged out by harrows, and ſhould be burnt. This repeated as often as the farmer can conveniently during a dry ſeaſon, or repeated another ſeaſon, can ſcarcely fail to complete the cure. *Colt's foot*, which is propagated by the root, may likewiſe be deſtroyed by ſowing the ground with rye-graſs, on any plant which, coming up early in the ſpring, ſhadows and ſmothers it, whereby it dies in a few years.

The ſecond are deſtroyed by draining the earth

of

of its ſuperfluous moiſture, and by warming it with *lime*, *aſhes*, *gravel*, *ſhelly ſea-ſand*, &c.

The third are deſtroyed by cutting them down when in full ſap and vigour: for the ſudden interruption which this gives to the motion of the ſap, cauſes it to ſtagnate in the roots, and putrify there. Some few and weak lateral ſhoots may be made; but they too being cut in the ſame manner, the roots are entirely putrified by degrees, and, inſtead of annoying, become a manure.

The fourth can be deſtroyed only by frequent fallows, and conſtantly cutting, or rather plowing them down before they run to ſeed. Some, for inſtance the wild oats, may be mowed for hay, but it is much more beneficial to the land to have them turned down; for by that means, inſtead of being exhauſted by frequent crops, it is manured by thoſe enemies to uſeful grain.

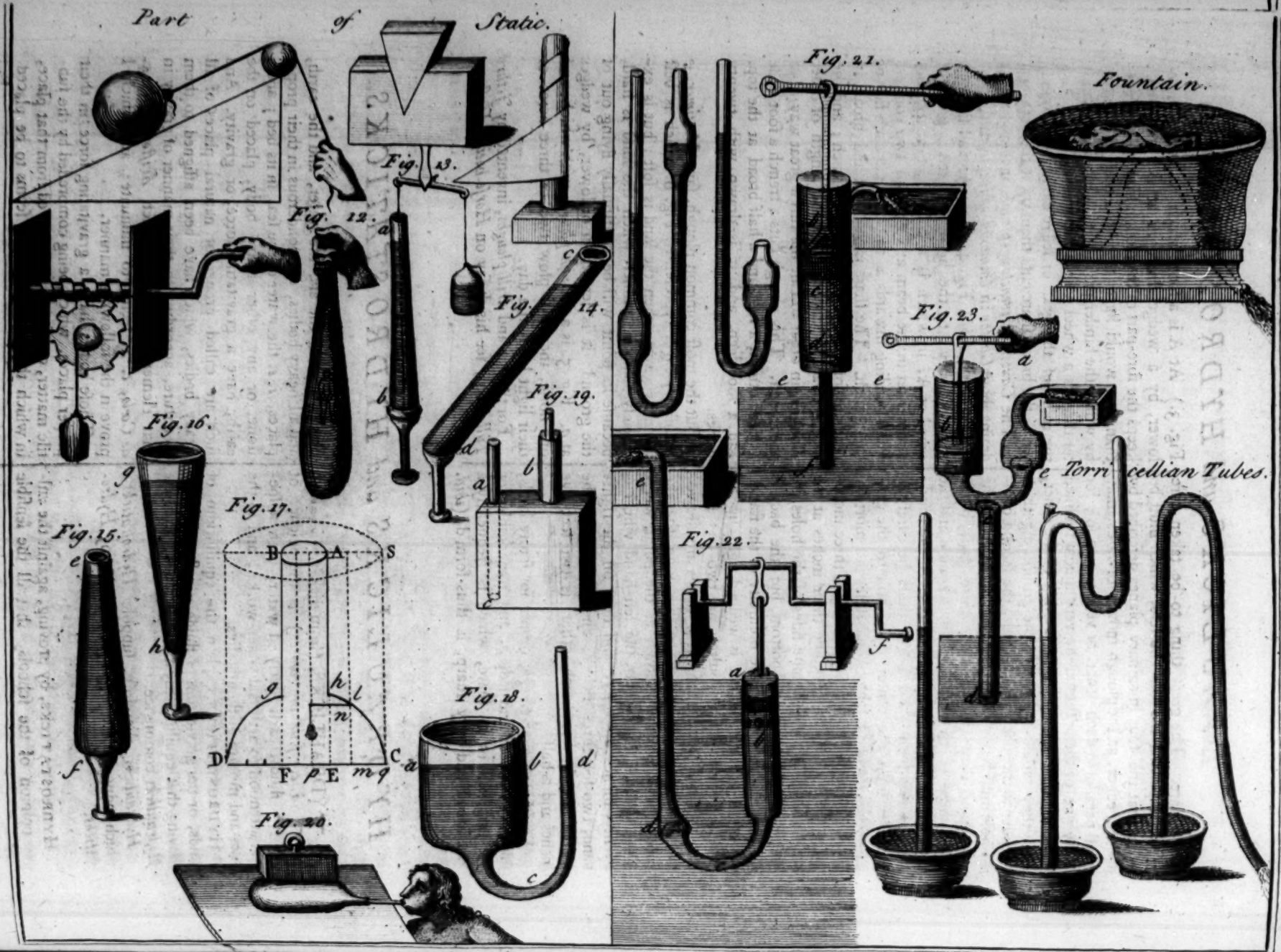
Banks and hedges ſhould be preſerved free from weeds; not only to preſerve their bottoms thicker, but alſo to prevent the ſeeds of weeds from being carried into the adjacent fields, by winds, by which means the corn muſt be conſtantly peſtered with them.

The common *two wheel plough*. (See *Fig.* 1. in the plate) uſed almoſt in all the counties in the ſouth of *England*, is commonly divided into two parts, the plough-head, and the plough-tail. The plough-head contains the two wheels A, B, and their axis, or iron-ſpindle, which paſſes through the box C, and turns round both in it and in the wheels; the two crow-ſtaves D, D, faſtened perpendicularly into the box, having in each two rows of holes, in order to raiſe or ſink the beam, by pinning up or down the pillow E, to increaſe or diminiſh the depth of the furrow; the gallows F, through which the crow-ſtaves paſs at top, by mortoiſes into which they are pinned; G the wilds, with its links and crooks of iron, by which the plough is drawn; H the tow-chain, which faſtens the plough-tail to the plough head, by the collar I at one end, and by the other end paſſing thro' a hole in the middle of the box, where it is pinned in by the ſtake K; L the bridle-chain, one end of which is faſtened to the beam with a pin, and the other end to the top of the ſtake, which ſtake is held up to the left crow-ſtaff, by the end of the wyth or rope M paſſing round it above, and under the end of the gallows below, or by the end of the bridle-chain itſelf, when that is long enough. The plough-tail conſiſts of the beam, N; the coulter, O; the ſhare, P; and the ſheat, Q; the hinder ſheat, R, paſſing through the beam near its end; S the ſhort handle, faſtened to the top of the hinder ſheat by a pin, and to the top of the fore-ſheet by another pin; T the drock, which belongs to the right-ſide of the plough-tail, and to which the ground-wriſt V is faſtened; as is the earth-board, whoſe fore-part W, is ſeen before the ſheat; as alſo the long handle X, whoſe fore-part Y appears before the ſheat, and is faſtened to the drock by the pin at *a*, the other end of which pin goes into the beam. Z is the double retch, which holds up the ſheat, and paſſes through the beam to be faſtened by its ſcrews and nuts at *b* and *c*.

The ſtructure of the *four-coultered plough*, (*ibid.* Fig. 2.) is in ſeveral reſpects different from this, though in general founded on it. Its beam is ten feet four inches long, whereas that of the common plough is but eight feet: it differs alſo in ſhape; for as the other is ſtrait from one end to the other, this is ſtrait only from *a* to *b*, and thence turns up, in the manner ſhewn in the plate; ſo that a perpendicular line let down from the corner at *a*, to the even ſurface on which the plough ſtands, would be eleven inches and a half, which is its height in that place; and if another line was let down from the turning of the beam at *b*, to the ſame ſurface, it would be one foot eight inches and a half, which is the height the beam ſtands from the ground at that part; and a third line let down to the ſurface from the bottom of the beam, at that part which bears upon the pillow, will ſhew the beam to be, in that part, two feet ten inches high above the ſurface. At the diſtance of three feet two inches from the end of the beam, at the plough-tail, the firſt coulter, or that next the ſhare, is let through: and at thirteen inches from this, a ſecond coulter is let through: a third at the ſame diſtance from that; and, finally, a fourth at the ſame diſtance from the third. The crookedneſs of the beam is to avoid the too great length of the fore-moſt coulters, which would be ſo long if the beam was ſtrait all the way, that they would be apt to bend and be diſplaced, unleſs they were vaſtly thick and clumſy.

The ſheat in this plough is to be ſeven inches broad, and the fixing the ſheat in this, as well as in the common plough, is the niceſt part, and requires the utmoſt art of the maker; for ſuppoſing the axis of the beam, and the left-ſide of the ſhare to be both horizontal, they muſt never be ſet parallel to each other; but the ſtrait ſide of the ſhare muſt make an angle on the left ſide of the beam, which muſt be very acute, that the tail of the ſhare may preſs leſs againſt the ſide of the trench than the point does: this angle is ſhewn by the pricked lines at the bottom of *Fig.* 1. where the line *e f* is ſuppoſed to be the axis of the beam let down to the ground, and the line *g h*, parallel to the left-ſide

of


Part of Static.
Fig. 12.
Fig. 13.
Fig. 14.
Fig. 15.
Fig. 16.
Fig. 17.
Fig. 18.
Fig. 19.
Fig. 20.
Fig. 21.
Fig. 22.
Fig. 23.
Fountain.
Torricellian Tubes.

of the ſhare. The great thing to be taken care of, is the placing the four coulters, which muſt be ſo ſet that the four imaginary planes deſcribed by the four edges, as the plough moves forwards, may be all parallel to each other, or very nearly ſo; for if any one of them ſhould be very much inclined to, or ſhould recede much from either of the other, then they would not enter the ground together. In order to the placing them thus, the ſecond coulter-hole muſt be two inches and a half more on the right-hand than the firſt; the third muſt be as much more to the right of the ſecond; and the fourth the ſame diſtance to the right of the third; and this two inches and a half muſt be carefully meaſured from the center of one hole to the center of the other. Each of theſe holes is a mortoiſe of an inch and a quarter wide, and is three inches and a half long at the top, and three inches at the bottom. The two oppoſite ſides of the holes are parallel to the top and bottom, but the back is oblique, and determines the obliquity of the ſtanding of the coulter, which is wedged tight up by pieces of wood. The coulters are two feet eight inches long, of which ſixteen inches are allowed for the handles, which is to be thus long, that the coulter may be drawn down as the point wears away. As to the wheels, the left-hand wheel is twenty inches diameter, and that on the right-hand, two feet three inches; and the diſtance the wheels are ſet from each other, is two feet five inches and a half.

The *Lincolnſhire-plough*, proper for fenny lands, ſubject to weeds and ſedges, and remarkable for the largeneſs of its ſhare, which is frequently a foot broad and very ſharp, is thus form'd, (*ibid.* Fig. 3.) At A is a foot, which is ſet higher or lower, by a wedge drove in at B; and which keeps the fore-part of the plough from going deeper than they would have it. At C there are wedges by which the hinder part is ſet. Inſtead of a coulter there is a wheel with a ſharp edge, which cuts the roots of the graſs or ſedge as it turns round, while the broad ſhare cuts them up at the bottom.

The *Caxton* or *trenching-plough*, invented to cut drains about *Caxton* in *Cambridgeſhire*, in ſtiff, miry, clay-ground, (*ibid.* Fig. 4.) is larger and ſtronger than ordinary: to the beam is fixed a piece of wood at A, in which is a coulter ſet at B, and another ſet in the beam at C, which two coulters ſtand bending inwards as at D, to cut each ſide of the trench. The ſhare is very flat and broad, in order to form the bottom of the trench; and the mould board is three times the length of other ploughs, in order to caſt the turf a great way from the trench. This plough cuts a trench a foot wide at the bottom, a foot and a half broad at the top, and a foot deep, and it is drawn with twenty horſes.

But the moſt common plough, ſays *Mortimer*, is the *dray plough*, repreſented Fig. 6. which is beſt for miry clays, when the land is ſoft; but is extremely bad in ſummer, when the land is hard, becauſe its point will be continually flying out of the ground: it is ſet higher or lower, by wedges at *a*. Fig. 5. is a *Spaniſh-plough*, with which, and one horſe, they will plow two or three acres of their light lands in a day.

For the *hoe* and *drill-ploughs*, invented by *Jethro Tull*, Eſq; ſee his Eſſay on *Horſe-hoeing Huſbandry*.

HYDRAULICKS and HYDROSTATICKS.

HYDRAULICKS, (from the *Greek* ὑδραυλος, *i. e. ſounding water*) is the ſcience of fluids, particularly of water, with a ſpecial attention to artificial water-works; and to the laws and motion of fluid bodies.

HYDROSTATICKS explain the equilibrium of fluids, or the gravitation of fluids at reſt; upon removing that equilibrium, motion enſues; and here *Hydraulicks* commence.

Hydraulicks, therefore, ſuppoſe *Hydroſtaticks*; which induces me to begin this treatiſe by *Hydroſtaticks*.

HYDROSTATICKS, by proving, againſt the vulgar opinion of the ſchools, that all the ſenſible elements, *viz.* the air, the water, and the earth, and all heavy bodies, are ponderous in their proper places, *i. e.* the water of the ſea, in its bed; and a ſtone, or any other heavy body, placed on the earth, have a gravitating force, or gravity. And ſuch are called proper or natural places of all heavy bodies, which have been aſſigned to them by nature, according to their manner of gravity in that elementary region, which *Ariſtotle*, *lib.* 4. *de Cœlo*, *c.* 4. ſeems to inſinuate; and which I prove in the following manner.

Thoſe bodies have a gravitating force in their proper places, which being compreſſed by the ſubtile matter, can ſcarce be removed from that place, in which the ratio of gravity ſeems to be placed.

But

But the ſenſible elements, and all heavy bodies, compreſſed by the ſubtile matter, can ſcarce be removed from their place; as it appears in water, earth, *&c.* which cannot be raiſed upward without difficulty:—Therefore the ſenſible elements, and all other heavy bodies, have a gravitating force in their proper place. For the water of the ſea, by its gravity, does no leſs compreſs its bed, than water contained in a veſſel, compreſſes by its gravity, the bottom of that veſſel; but it is confirmed by repeated experiments, that water contained in a veſſel, gravitates on its bottom; and that the water, which occupies that bottom, is preſſed by the other water over it. Whence if the ſide of a veſſel full of water be perforated near its baſe, the greater is the quantity of the water contained in that vaſe, the further will it flow through that hole; therefore, *&c.*

To this it will be objected, firſt, that a heavy body, as lead, has leſs weight in water than in the air; ſince water diminiſhes very near a twelfth part of the weight of the lead; and takes off, likewiſe, very near a ninth part of the weight of copper; ſo that if the weight of the body, and that of the water, be equal; that body will be found to have no gravity in the water: and therefore water has no gravity in its proper place.

I anſwer, that what has deceived moſt philoſophers, on this point, is, that they made no diſtinction between an *abſolute* and *relative gravity*.

We call *abſolute gravity*, that whereby a body is heavy in itſelf, or tends downwards: and a *relative* one, that whereby a body is heavy with reſpect to our ſenſes; therefore lead loſes a twelfth part of its *relative gravity* in the water, becauſe we feel it a twelfth part lighter; but it loſes nothing of its *abſolute gravity*.

If I be aſked why lead loſes almoſt a twelfth part of its gravity in the water? I'll anſwer, that the reaſon of this phænomenon is very eaſy, *viz.* that a maſs of lead is almoſt twelve times heavier than a maſs of water of the ſame volume, or magnitude; whence that the water may be in an equilibrium with the lead, its volume muſt be twelve times greater than that of the lead.—Hence if a wooden beam be as ponderous as an equal volume of water, in whatever place it ſhall be put in the water, there it will remain, without riſing higher, or deſcending lower; and will have the effect of a volume of water, which are in an equilibrium, with parts equal and like to it.

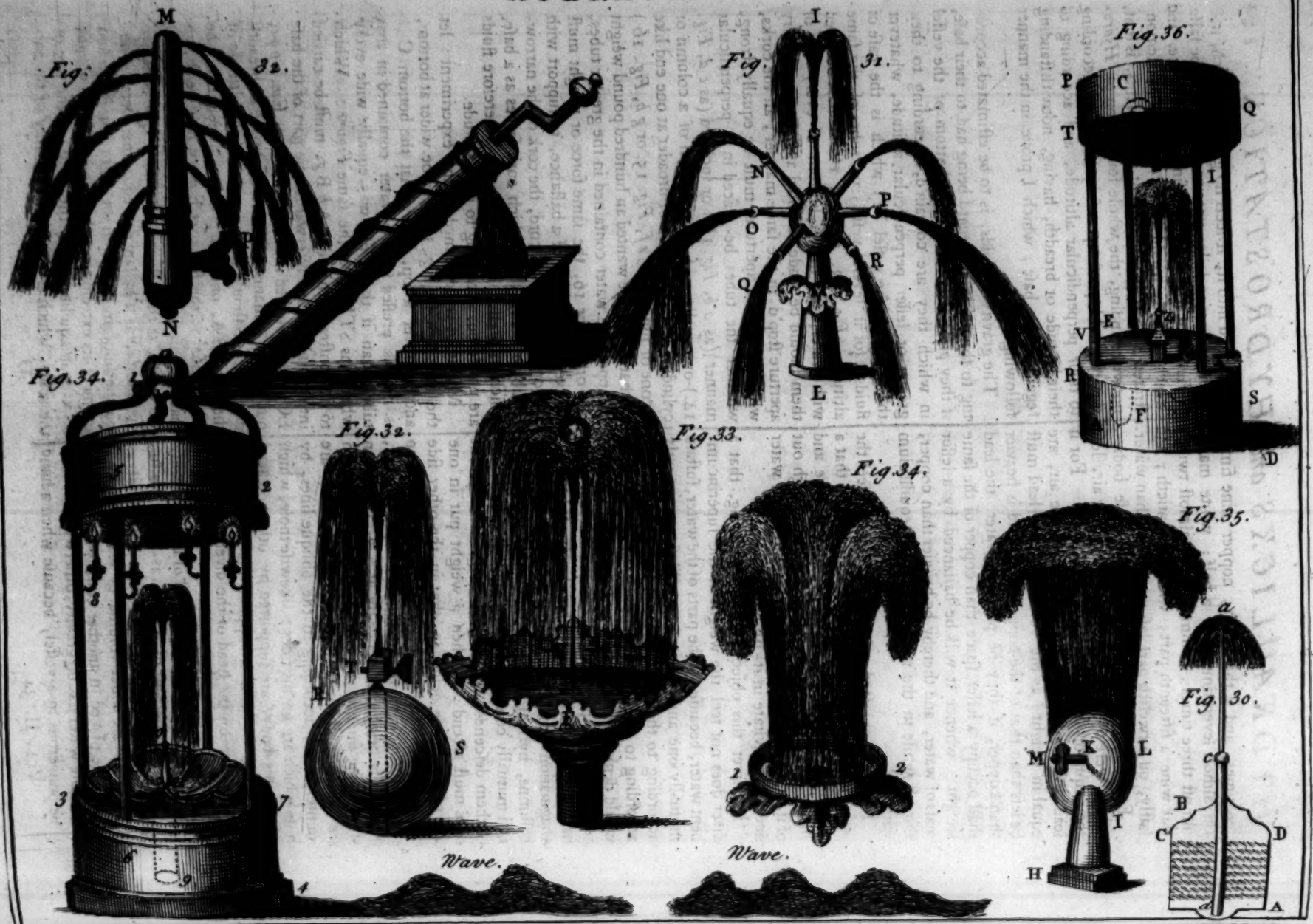
But if that wood be much lighter than the water, *v. gr.* twice, thrice, four times, five times, ſix times, *&c.* lighter than the water, it will take up half, a third, a fourth, a fifth, or a ſixth part of its weight of the water. The ſame as a boat only full of air, ſcarce penetrates a ſixth part of its weight of water; but if it be loaded with ſand, ſtones, or men, together with the air, ſo that the whole maſs of the boat, men, air, and ſand, approaches the gravity of an equal volume of water, the boat will be depreſſed lower; but if, at laſt it be too much loaded, and grows heavier than an equal maſs of water, it will be ready to ſink.

The ſame may be ſaid of a glaſs bottle full of air, which repreſents ſometimes a human figure, (*Fig.* 12. in Plate *Hydroſtaticks*) for that bottle being put in a tube or pipe of glaſs, full of water, as it is ſomewhat lighter than a like volume of water, ſome part thereof is ſeen above the water. But its having a very ſmall hole on the ſide; if while it is in the water, ſome of the air be pumped out, to make room for as much water; then, by the ſingle compreſſion of the finger on the orifice of the pipe, it will happen that more water ſhall enter the bottle through the hole on the ſide, and depreſs it more down towards the bottom of the tube: but if the finger be removed, the air left in the figure, will, by its elaſtick virtue, thurſt out the little quantity of water, which had entered through the hole, and the figure being again rendered thereby lighter than an equal volume of water, will return upwards. But if ſo much air be pumped from it, as to make room for a greater quantity of water, then it will deſcend of its own proper weight to the bottom of the tube, and not aſcend to the top but by pumping.

There are alſo other glaſs bottles, from which a greater or leſs quantity of air has been taken out, which being likewiſe incloſed in a tube full of water, where the water grows thicker, by cold, aſcend and deſcend, if the water, thro' heat, be rarified; whereby the degree of heat may be known at any time. But I'll ſpeak of the *Thermometer*, or inſtrument proper to meaſure the degrees of heat, in another place. Therefore, ſo often as a body is much more heavy, as often it is precipitated downwards; but it only loſes as much of its relative gravity, as the like volume of water is ſuſpended over it, *v. gr.* copper, which is nine times heavier than water, loſes a ninth part of its weight, as gold loſes a nineteenth part. Therefore, if you ſuſpend gold in open air, and afterwards put it into water, while it remains of the ſame weight ſuſpended in the air, you may obſerve, that a ninth part of the equality of weight, muſt be taken off, to make it of an equilibrium with the water.

In this manner you'll eaſily diſcover, how much all ſorts of bodies are heavier than water. For gold is nineteen times heavier than the ſame volume of river water; quickſilver almoſt fourteen times; lead almoſt twelve; ſilver

HYDRAULICKS



ten times, and a thirteenth; copper nine times; tin almoſt ſeven times and a half; white marble almoſt three times; common ſtone almoſt twice but wine a fifteenth part; wax a twentieth; and laſtly, oil a twelfth part leſs ponderous than water.

From all theſe it appears, why thoſe bodies, which were of equal weight, while in the air, loſe their equilibrium when weighed in water. For if lead and copper, while ſuſpended in the air, are equal in weight; as the volume of the lead muſt be leſs than that of the copper, ſince lead is heavier than copper, if they be put into water, the lead ſhall occupy a leſſer ſpace than copper of the ſame weight; whence it will be ballanced by a leſſer maſs of water, and thereby be heavier than copper, though while in the air it was in an equilibrium with it.

It may be objected, that a diver does not feel the weight of the ſuperincumbent water; and that a pail full of water can be eaſily moved here and there, while it remains in the well; though out of it, it feels very heavy; and therefore, that water does not gravitate in its proper place.

I anſwer this objection, by obſerving, that a diver does not feel the weight of the ſuperincumbent water, becauſe all the parts of the water, ſuſtain mutually one another in an equilibrium, not only according to their perpendicular lines, but likewiſe according to their oblique ones. For, 1. Who would deny, that they are in an equilibrium, according to their perpendicular lines? Since it is the nature of liquids, that, if they be divided by our imagination into ſeveral equal columns, all thoſe columns, by reaſon of the fluidity of their parts, will mutually counterpoiſe one another; for if one of them deſcends, the neighbouring, and adjacent ones muſt aſcend; as when a weight put in one ſide of a ballance deſcends, that in the other ſide of the ſame ballance muſt aſcend; for there is no greater reaſon that a column ſhould conquer another, than of its being conquer'd by it. 2. By reaſon of the ſame fluidity of the water, thoſe parts which are ſuperincumbent on the head of the diver, are counterpoiſed, according to the oblique lines, by thoſe which are on his ſides: likewiſe thoſe, which environ his body, are ſupported by others placed round them. Whence it happens, that their weight is felt neither on the head of the diver, nor on his ſides.

For the ſame reaſon, a pail full of water is eaſily rais'd from the bottom of a well, as far as the ſuperficies of the water of the well, becauſe it is ſupported by an equal volume of water, as by a counterpoiſe placed in another equal column; and not becauſe water has no gravity, otherwiſe it would not be ponderous in a veſſel, becauſe when a hand is plunged into it, it feels no gravity, which, notwithſtanding, a daily experience proves to be falſe.

But what is more ſurpriſing in this place, and which no body would believe, if it was not demonſtrated by certain and evident experiments, is that, notwithſtanding, the whole foundation of *Hydroſtaticks*, fluids preſs upon ſubject bodies, according to their perpendicular altitude, and according to their latitude or breadth, having, notwithſtanding regard to the baſe; which I prove in the manner following.

The gravity of fluids, is to be eſtimated according to their altitude, regard being had to their baſe, if they preſs more or leſs the bottom of the veſſel in which they are contain'd, according to their greater or leſſer perpendicular altitude, whatever the figure of the veſſel be; which is the caſe of fluids: for if ſeveral veſſels or tubes of the ſame altitude (*Fig.* 13, 14, 15, 16, *ibid.*) be filled with water, and in the bottom of every one of them ſhould be made an equal aperture, and every aperture ſtop'd in the ſame manner; all the corks, which ſtop thoſe apertures muſt be equally ſtrong, whether the tubes be placed in a perpendicular manner (as *a b*, *Fig.* 13.) or inclined (as *c d*, *Fig.* 14.) or equally wide in the form of a column or cylinder, as *a b* and *c d*; or broader at one end like a cone or funnel (as *e f*, *Fig.* 15. or *g h*, *Fig.* 16) So that if there be wanted an hundred pound weight to ſupport the water contained in the greater tubes, 14, or 15, or 16, the ſame force or weight muſt be fixed at the beam of a ballance, to ſupport with an iron-wire or ſmall cord, the cork of the narrower tube *a b Fig.* 13. which cork ſerves as a baſe, which is preſſed by the water:—Therefore fluids are ponderous according to their altitude.

My proof is confirmed by this experiment: let the tube ABCD, *Fig.* 17. *ibid.* be wider at bottom, and narrower a top, I ſay, that the bottom CD is no leſs preſſed by the water contained in that tube, than if the veſſel was equally wide every where, as STDC, of the ſame *Figure*: Which to demonſtrate, the ſides A *b* B *g*, muſt be carried into E and F; and afterwards, the part of the baſe EC is to be divided into the equal parts E *m*, *n p q c*, but in ſuch a manner, that the latitude or breadth of every one ſhould not exceed half the altitude of the tube BA, or EF. Which done, if E *p* be taken equal to the firſt part E *m*, it may be ſhewn that the column E *i* preſſes equally the bottom of the veſſel, as the column *p* A; for if you conceive the line *l i*, as a ballance of equal members, *n* being the fulcrum thereof in the right line AE; and at one of its extremities, *l* be ſuſpended, the weight *v*, kept in equilibrium by the point *i* of the ſide of the veſſel, which is the other extremity of the ballance,

lance, certainly the fulcrum *n* will ſuſtain both the weight *v*, and the reſiſtance of the point *i* equal to the weight *v*, and conſequently will carry twice the weight of *v*.

Then let it be imagined that the water of the column A *p*, has the ſame effect on the bottom *p* E, as the weight *r* has on the arm *u l*; therefore, as the point *i* of the ſide of the vaſe hinders the weight *r* from deſcending, likewiſe the part *b i* hinders the water of the column A *p*, from forcing upwards the water of the column E *i*, and therefore that column E *i* will by its reſiſtance preſs as much the bottom, as the column A *p* preſſes *p* E in gravitating.

In the ſame manner the part of the baſe *m q*, is as much preſſed by the column *i q*, as the part E *m* by the column E *i*, i. e. as much as the part *p* E is preſſed by the column *p* A: and thus the whole baſe is as much preſſed by the water contained in the vaſe D B A C, as it ſhould be preſſed by the water filling up the whole veſſel STDC, which was to be demonſtrated.

The fluidity of the water is the cauſe that the column A *p* exerciſes its ſtrength on the column E *i*; for if the water ſhould be frozen, thoſe columns ſhould have no power over one another; therefore what we ſay of the water cannot be applied to ice.

To confirm and illuſtrate this doctrine of the preſſure of the fluids, in the ratio of the baſe and altitude, provide a metallick veſſel, ſo contrived as that the bottom may be moveable, and to that end fitted in the cavity of the veſſel with a rim of wet leather, to ſlide without letting any water paſs: then through a hole in the top apply ſucceſſively ſeveral tubes of equal altitudes, but different diameters. Laſtly, faſtening a ſtring to the beam of a ballance, and fixing the other end by a little ring to the moveable bottom: put weights in the other ſcale, till they be ſufficient to raiſe the bottom: then will you not only find that the ſame weight is required, what diameter or magnitude ſoever the tube be of; but even that the weight which will raiſe the bottom, when preſſed by the ſmalleſt tube, will raiſe it when preſſed by the whole cylinder.

The moſt ſolid and ponderous body, which near the ſurface of the water would ſink with great velocity; yet if placed at a greater depth than twenty times its own thickneſs will not ſink, unleſs aſſiſted by the weight of the incumbent water.

Thus immerge the lower end of a ſlender glaſs tube, in a veſſel of mercury; then ſtopping the upper end with your finger, you will by that means keep about half an inch of that ponderous fluid ſuſpended in the tube. Laſtly, keeping the finger thus, immerge the tube in a long glaſs of water, till the little column of mercury be more than thirteen or fourteen times its length under water; then removing the finger, you will find that the mercury will be kept ſuſpended in the tube by the preſſure of the water upwards: but if you raiſe the tube very little above the former ſtation, the mercury will immediately run out; whereof, if before you had removed the finger from the top, you had ſunk the pipe ſo low, as that the mercury were twelve or fourteen inches, *&c.* below the ſurface of the water, the mercury would be violently forced up, and make ſeveral aſcents and deſcents in the tube, till it had gained its former ſtation, according to the laws of ſpecifick gravity.

We may alſo make uſe in this place, of the experiment of a ſiphon; for if water be put in a ſiphon or inflexed tube (*a b e d c*, *Fig.* 18. *ibid.*) though one limb, *viz. a b*, be an hundred times larger than the other, *viz. c d*, the water will notwithſtanding remain ſuſpended in both limbs at the ſame altitude; which could not happen unleſs water was ponderous according to its altitude, or ſhould preſs the point *e*. For as there is a greater volume of water in the larger limb, it ſhould force upwards that contained in the ſlenderer limb, which is contrary to experience. Therefore water and other liquors gravitate in the ratio of their altitude.

Now what has been obſerved in the equilibrium of ſolids, the ſame is found in fluids. For then the water muſt be in an equilibrium, ſince on one part its volume, and on the other the ratio of its velocity is reciprocal; which is the caſe of the aforeſaid experiment of the ſiphon, where the volume of the water contained in both limbs, and the ratio of its velocity are reciprocal: for when you'll have poured a hundred times more water into the tube *a b*, than into *c d*, when that will be depreſſed towards *e* to the height of an ounce or inch, then that which is in the ſlenderer tube, or the limb *c d*, will riſe to the altitude of an hundred ounces: ſo that the greater the volume of water is in the larger tube, the greater is its velocity in the leſſer, by reaſon of the amplitude of each tube. Therefore it is neceſſary that the water ſhould be in an equilibrium in both, and gravitate equally every way on the point *e*.

This is ſo very true, that if there be water in a large veſſel (*Fig.* 19. *ibid.*) and the two tubes *a* and *b* be adapted to it, of which *b* be an hundred times thicker than *a*; water put in the tube *a* of a pound, will be equivalent to the weight of an hundred pounds put in the tube *b*. For the force or power is no leſs in the weight of one pound, for it to raiſe the other weight of a hundred pounds of water in the ſpace of one ounce, as it ſhould happen here,

than

than it is in the hundred pounds, to raiſe one pound in the ſpace of one ounce.

Hence, if a ſmall tube or pipe be adapted to the orifice of a hog's bladder (*Fig.* 20. *ibid.*) which is an hundred times narrower than the circumference of the bladder, as the wind blows through that ſmall tube into the bladder, has an hundred times a greater velocity of motion in the ſmall tube, than in the bladder, for though the wind or breath conſidered in itſelf, has only the force of one pound, it is notwithſtanding a weight equivalent to a weight of a hundred pounds; and if the bladder be preſſed by a ninety-nine pounds weight, that weight will be lifted up by the ſingle breath of the mouth introduced through that pipe into the bladder. Notwithſtanding this, ſeveral imagine, that the water contained in the tube *a*, *Fig.* 19 *ibid.* and which has the force of one pound, is only ponderous on the part which is immediately under it. For the propriety of *liquids* incloſed in veſſels is ſuch, that if they be compreſſed in any place, the force of the compreſſion inclines on every part of the veſſel wherein they are contained; whence if any of thoſe parts cannot bear that force either upwards or downwards, or on the ſides, it will preſently break. Hence it is, what we have already mentioned, that liquids are not only ponderous according to their perpendicular lines only, but likewiſe according to their oblique ones, by reaſon of the fluidity of their parts. Therefore the water of the tube *a* is ſaid to act, not only on the part *c* of the vaſe ſubject to it, but likewiſe on the orifice of the tube *b*; the ſame as the water of the leſſer tube in the ſiphon *a b e d c*, *Fig.* 18. *ibid.* ſupports in an equilibrium, the other water contained in the larger limbs.

It may be objected to this, that in the ſiphon, one limb whereof is very narrow, and the other very wide, the water in the narrower limb is ſuſtained higher than that contained in the broader; and therefore fluids do not always gravitate according to their altitude.

I anſwer, that the water being raiſed higher in the narrower tube than in the broader, is firſt to be attributed to the texture of the parts, whereby the ſmall fibres of the water being inſerted into the meatus of the glaſs of the narrower tube, adhere to its parietes or ſides, and are raiſed higher. Beſides, there is no doubt that the air ſuper-incumbent on the orifice of the narrower tube, preſſes with a far leſs force the water incloſed in it, than that contained in the larger limb, having a much more free acceſs into the larger tube than into the narrower

So far I have explained the laws of *Hydroſtaticks*, let us now paſs to thoſe of HYDRAULICKS; proceeding afterwards to the application thereof to practice, as to conducting and raiſing of water, with the conſtructing of engines for that purpoſe.

The firſt of the *hydraulick laws of fluids* is, that the velocity of a fluid, as water moved by the preſſure of a ſuperincumbent fluid, as air, is equal at equal depths, and unequal at unequal depths. For, the preſſure being equal at equal depths, the velocity ariſing thence muſt be ſo too, and *vice verſâ*; yet the velocity does not follow the ſame proportion as the depth; notwithſtanding, that the preſſure whence the velocity ariſes, does increaſe in the proportion of the depth. But here the quantity of the matter is concerned; and the quantity of motion which is compounded of the ratio of the quantity and velocity of the matter increaſed in equal times as the ſquares of the velocities.

The ſecond law is, that the velocity of a fluid, ariſing from the preſſure of a ſuperincumbent fluid, at any depth, is the ſame as that, which a body would acquire in falling from a height equal to the depth.

The third law is, that if two tubes of equal diameters full of any fluid, be placed any how, either erect or inclined, provided they be of the ſame altitude, they will diſcharge equal quantities of the fluid in equal times. That tubes every way equal, ſhould under the ſame circumſtances empty themſelves equally is evident; and that the bottom of a perpendicular tube is preſſed with the ſame force as that of an inclined one, when their altitudes are equal, has already been ſhewn; whence it eaſily follows, that they muſt yield equal quantities of water, *&c.*

The fourth is, that if two tubes of equal altitudes, but unequal apertures, be kept full of water; the quantities of water they yield in the ſame time will be as the diameters; and this whether they be erect or any how inclined. Hence if the apertures be circular, the quantity of water emptied in the ſame time, are in a duplicate ratio of the diameters.

The fifth law is, that if the apertures of two tubes be equal, the quantity of water diſcharged in the ſame time will be as the velocities.

The ſixth is, that if two tubes have equal apertures, and unequal altitudes, the quantity of water diſcharged from the greater tube, will be to that diſcharged from the leſſer in the ſame time in a ſubduplicate ratio of their altitudes. Hence, 1. The altitudes of water diſcharged through equal apertures, will be in a duplicate ratio of the waters diſcharged in the ſame time: and as the quantities of water are as the velocities; the velocities are likewiſe in a ſubduplicate ratio of their altitudes. Hence, 2. The ratio of the waters diſcharged by two tubes, together with the altitude of one of

them being given, we have a method of finding the altitude of the other, *viz.* by finding a fourth proportional to the three given quantities; which proportional, multiplied by itſelf, gives the altitude required. Hence alſo, 3. The ratio of the altitude of two tubes of equal apertures being given, as alſo the quantity of water diſcharged by one of them, we have a method of determinating the quantity the other ſhall diſcharge in the ſame time. Thus to the given altitudes, and the ſquares of the quantity of water diſcharged at one aperture, find a fourth proportional. The ſquare root of this will be the quantity of water required.

Suppoſe, *e. gr.* the height of the tubes, as 9 to 25, and the quantity of water diſcharged at one of them three inches; that diſcharged by the other will be $= \sqrt{(9.25:9)} = \sqrt{25} = 5$.

The ſeventh law is, that if the altitudes of two tubes be unequal, and the apertures likewiſe unequal, the quantities of water diſcharged in the ſame time, will be a ratio compounded of the ſimple ratio of the apertures, and the ſubduplicate one of the altitudes. And hence if the quantities of water diſcharged in the ſame time by two tubes, whoſe apertures and altitudes are unequal, be equal; the apertures are reciprocally as the roots of the altitudes, and the altitudes in a reciprocal ratio of the ſquares of the apertures.

The eighth is, that if the altitudes of two tubes be equal, the water will flow out with equal velocity, however unequal the apertures be.

The ninth, if the altitudes of two tubes, and alſo their apertures be unequal, the velocity of the waters diſcharged are in a ſubduplicate ratio of their altitudes. And hence, 1. As the velocities of waters flowing out at equal apertures, when the altitudes are unequal, are alſo in a ſubduplicate ratio of the altitudes, and, as this ratio is equal, if the altitudes be equal; it appears in the general, that the velocities of water flowing out of tubes, are in a ſubduplicate ratio of the altitudes. Hence alſo, 2. The ſquares of the velocities are as the altitudes.

Mariotte found from repeated experiments, that if a veſſel has a tube fitted to it, there will be more water evacuated through the tube, than there could have been in the ſame time, through the aperture of the veſſel without the tube: and that the motion of the fluid is accelerated ſo much the more, as the tube is the longer, *e. gr.* the altitude of a veſſel being one foot that of the tube three feet, and the diameter of the aperture three lines; $6\frac{1}{2}$ ſeptiers of water were diſcharged in the ſpace of one minute, whereof, upon taking off the tube, only four ſeptiers were diſcharged. Again, when the length of the tube was ſix feet, and the diameter of the aperture an inch, the whole quantity of water run out in thirty-ſeven ſeconds; but cutting off half the tube, the veſſel was not evacuated in leſs than forty-five ſeconds; and taking it quite away, in leſs than ninety-five ſeconds.

The tenth law is, that the altitudes and apertures of two cylinders full of water being the ſame; one of them will diſcharge double the quantity of water diſcharged in the ſame time by the other; if the firſt be kept continually full, while the other runs itſelf empty. For the velocity of the full veſſel will be equable, and that of the other continually retarded. Now it is demonſttated, that if two bodies be impelled by the ſame force, and the one proceeds equably, and the ſecond is equably retarded; by that time they have loſt all their motion, the one has moved double the ſpace of the other.

The eleventh, if two tubes have the ſame altitudes and equal apertures, the time wherein they will empty themſelves will be in the ratio of their caſes.

The twelfth, cylindrick and priſmatick veſſels empty themſelves by this law, that the quantities of water diſcharged in equal times, decreaſe according to the uneven numbers, 1, 3, 5, 7, 9, *&c.* taken backwards. For the velocity of the deſcending level, is continually decreaſing in the ſubduplicate ratio of the decreaſing altitudes: but the velocity of a heavy body deſcending, increaſes in the ſubduplicate ratio of the increaſing altitudes.

The thirteenth is, that if water deſcending through a tube, ſpouts upon an aperture, whoſe direction is vertical; it will riſe to the ſame altitude, at which the level of the water in the veſſel does ſtand; for ſince the direction of the aperture is vertical, the direction of the water ſpouting through it will be ſo too; conſequently the water muſt riſe to the height of the level of the water in the veſſel.

The fourteenth law is, that water deſcending through an inclined tube, or a tube bent in any manner, will ſpout up through a perpendicular aperture to the height at which the level of the water in the veſſel ſtands,

The fifteenth law is, that the length or diſtances, to which water will ſpout, either through an inclined, or a horizontal aperture, are in a ſubduplicate ratio of the altitudes in the veſſel or tube. For ſince water ſpouted out through the aperture, endeavours to proceed in an horizontal line; and at the ſame time by the power of gravity, tends downwards in lines perpendicular to the ſame; nor can the one power hinder the other, inaſmuch as the directions are not contrary: it follows, that the water will arrive at the line propoſed, in the ſame time wherein it would have arrived at it, had there

there been no horizontal impulſe at all. Hence, as every body projected, either horizontally, or obliquely, in an unreſiſting medium, deſcribes a parabola; water projected either through a vertical or inclined ſpout, will deſcribe a parabola. Hence we have a way of making a delightful kind of water arbours or arches, *viz.* by placing ſeveral inclined tubes in the ſame right lines.

On theſe principles, we'll form ſeveral *hydraulick* engines, for the raiſing, &c. of fluids, as *pumps*, *ſiphons*, *fountains*, or *jets d'eaus*, &c. beginning with *pumps*.

A *Pump* is a machine formed on the model of a ſyringe, for the raiſing of water.

Pumps are diſtinguiſhed into ſeveral kinds, with regard to the ſeveral manners of their acting, as the *common*, or *ſucking pump*, *forcing pump*, *Cteſebes's pump*, *chain pump*, *arc pump*, *bur pump*, &c.

The *common* or *ſucking pump*, (*Fig.* 23. *ibid.*) is that which acts by the preſſure of the air, and whereby water is raiſed out of a lower into a higher place, not exceeding 32 feet. This *pump* is made of a hollow cylinder, or barrel, provided of any ſolid matter, uſually wood, and erected perpendicularly in a ſpring, or other ſource of water; the lower part of the cylinder being firſt fitted with a valve † *d*, which opens upwards. — A Piſton, * or embolus *b*, called the ſucker, furniſh'd with a valve *c*, which likewiſe opens upwards, is let down the cylinder; and for the more eaſy working upwards and downwards, furniſhed with a level or handle *a*. Now the embolus being drawn up, will leave a ſpace void of air, at leaſt in a great meaſure ſo: the preſſure, therefore, of the air on the ſurface of the ſtagnant water prevailing, will, by the laws of *hydroſtaticks*, lift up the valve *d*, firſt mentioned, and raiſe it to fill the cavity ſuppoſed void of air. — If then the embolus be again let down, the lower valve being now faſt cloſed with the weight of the incumbent water, upon preſſing the piſton, the water muſt open the upper valve *c*, and get into the embolus, by which it is raiſed up and diſcharged out of the ſpout. — Thus is the embolus alternately raiſed and depreſſed.

This aſcent of the water, the ancients, who ſuppoſed a *plenum*, attributed to nature, abhorrent of a *vacuum*; but the moderns, more reaſonably, as well as more intelligibly, attribute it to the preſſure of the atmoſphere, on the ſurface of the fluid. For, by drawing up the embolus, the air left in the cavity of the cylinder, muſt be exceedingly rarified; ſo that being no longer a counter-ballance to the air incumbent on the ſurface of the fluid; that prevails and forces the water thro' the little tube into the body of the *pump*.

The *forcing pump* (*Fig.* 24. *ibid.*) acts by mere impulſe or protruſion, and raiſes water to any height at pleaſure. This *pump* is made in this manner: a cylinder is divided by a diaphragm, or tranſverſe piece, fitted with a valve, opening upwards *d*, and thus immerged in water: an embolus *b*, furniſhed with a valve, is ſo fitted to an iron-rod *f*, moveable on a hinge at each end, as that it may be conveniently raiſed, and depreſſed by the hand. Now, upon preſſing the embolus, the water will open the valve, and thus aſcend into the cavity of the cylinder. But upon raiſing it again, the valve is ſhut, ſo that there is no paſſage for it that way; the other valve therefore becomes open'd, and the water mounts through it; and by repeating the agitation of the embolus, it is at length driven out thro' the ſpout.

The great difficulty of rectifying this *pump*, when out of order, on account of the chief ſeat of action being under water, makes people decline the uſe of it when they can do well without it, notwithſtanding its advantage of raiſing the water to any given height.

Cteſebes's pump (*Fig.* 25. *ibid.*) is the firſt and fineſt of all the kinds, and acts both by friction and compulſion. Its ſtructure and action is as follows. A braſs cylinder furniſhed with a valve *c*, is placed in the water. In this is fitted the embolus *b*, made of green wood, which will not ſwell in the water, and adjuſted to the aperture of the cylinder, with a covering of leather; but without any valve. Another tube *e*, is fitted on with a valve that opens upwards. Now the embolus being raiſed, the water opens the firſt valve *c*, and riſes into the

† A valve in *hydraulicks*, is a kind of lid, or cover, of a tube or veſſel, ſo contrived, as to open one way; but which, the more forcibly it is preſſed the other way, the cloſer it ſhuts the aperture. So that it either admits the entrance of a fluid into the tube, or veſſel, or prevents its re-entrance. In *hydraulick* engines, they are frequently of leather; their figure round; and are fitted to the bottom, or other parts of the barrel, &c. to ſhut the apertures. Sometimes they are made of two round pieces of leather, incloſed between two others of braſs, having divers perforations, which are covered with another piece of braſs, moveable upwards and downwards, on a kind of axis, which goes thro' the middle of them all. — Sometimes they are made of braſs, covered with leather, and furniſhed with a fine ſpring, which gives way upon a force applied againſt it: but upon the ceaſing of that, returns the valve over the aperture.

* The *piſton* or *embolus*, is a ſhort cylinder of metal, fitted exactly to the cavity of the barrel or body of the pump; and which being worked up and down alternately therein, raiſes the water; and when raiſed, preſſes it again, ſo as to make it force up the valve wherewith it is furniſhed, and ſo eſcape through the noſe of the pump.

cavity

cavity of the cylinder: and when the ſame embolus is again depreſſed, the laſt valve is opened *c*, and the water driven out thro' the tube.

This is the *pump* uſed among the antients, and that from which both the others are deduced. Sir *S. Morland* has endeavoured to increaſe its force, by leſſening the friction, which he has done to good effect, inſomuch as to make it work without almoſt any friction at all.

Note, That the other pumps I have mentioned, are only uſed in ſhips; and therefore I'll give their deſcription in the treatiſe of *Naval Architecture*, under the letter *N*.

From the *pump* we'll paſs to the SIPHON; which is a crooked tube, one branch or leg whereof is longer than the other; uſed in the raiſing of fluids, emptying of veſſels, and in various *hydroſtatical* experiments.

The word in the original *Greek* σίφων, ſignifies ſimply *tube*; whence ſome apply it to common tubes or pipes. *Wolfius* particularly deſcribes two veſſels, under the name of *ſiphons*; the one cylindrical in the middle, and conical at the two extremes; the other globular in the middle, with two narrow tubes fitted to it, axis-wiſe; both ſerving to take up a quantity of water, *&c.* and to retain it when up.

There is not a more uſeful and celebrated *ſiphon* than this. A crooked tube is provided of ſuch a length, and with ſuch an angle, that as when the orifice is placed on an horizontal plane, the height may not exceed 30 foot. For common uſes, a foot, or half a foot high ſuffices. If now the leſſer arm be immerged in water, or any other liquid, and the air be ſucked out of it by an aperture made for that purpoſe, till the liquor follow; the liquor will continue to flow out of the veſſel, through the tube, as long as the aperture is under the ſurface of the liquor. Inſtead of ſucking out the air, the event will be the ſame, if the *ſiphon* be at firſt filled with the fluid, and the upper aperture ſtopped with the finger, till the lower be immerged.

In ſucking, the air in the tube is rarified, and the equilibrium deſtroyed, conſequently the water muſt be raiſed into the leſſer leg, by the preponderating preſſure of the atmoſphere.

The *ſiphon* being thus filled, the atmoſphere preſſes equally on each extremity thereof; ſo as to ſuſtain an equal quantity of water in each leg: but the air not being able to ſuſtain all the water in the longer leg, unleſs it exceeds 32 feet in height; it will be more than able to ſuſtain that in the ſhorter leg: with the exceſs of force, therefore, it will raiſe new water into the ſhorter leg; which new water cannot make its way, but by protruding the firſt before it. By this means the water is continually driven out at the longer leg, as it is continually raiſed by the ſhorter.

If a filled *ſiphon* be ſo diſpoſed, as that both orifices be in the ſame horizontal line, the fluid will remain pendant in each leg, how unequal ſoever the length of the legs may be. Fluids, therefore, in *ſiphons*, ſeem, as it were to form one continued body; ſo that the heavier part deſcending like a chain, pulls the lighter after it. Obſerving, beſides, that the water will flow out, even thro' a *ſiphon* that is interrupted, by having the legs join'd together, by a much bigger tube full of air.

The moſt conſiderable machine of *hydraulicks*; the moſt agreeable to the ſight, and moſt diverting, is the *artificial fountain*.

The *artificial fountain*, is a machine, or contrivance, whereby water is ſpouted or darted up, called alſo *jet d'eau*.

M. *Mariette* ſhews, that a *jet d'eau* will never raiſe water ſo high as its reſervoir, but always fall ſhort of it by a ſpace, which is a ſubduplicate ratio of that height. He ſhews, likewiſe, that if a greater *jet* branch out into many ſmaller ones, or be diſtributed thro' ſeveral *jets*, the ſquare of the diameter of the main pipe, muſt be proportioned to the ſum of all the expences of its branches; and that if the reſervoir be 52 feet high, and the adjutage half an inch in diameter, the pipe ought to be three inches in diameter.

There are divers kinds of *artificial fountains*, ſome founded on the ſpring, or elaſticity of the air; and others on the preſſure or weight of the water, *&c.* the ſtructure of each hereof, being entertaining and curious, and affording a good illuſtration of the doctrine of *hydraulicks*, ſhall be here explained; beginning by the conſtruction of an *artificial fountain, playing by the ſpring, or elaſticity of the air*.

For the conſtruction of that kind of *artificial fountain*, a veſſel proper for a reſervoir as A B, of metal, glaſs, or the like, is provided; ending in a ſmall neck *c* a top. Through a thick neck a tube is put *c a*, traverſing the neck of the veſſel, till its lower orifice *d*, nearly, but not abſolutely, reach the bottom of the veſſel; the veſſel being firſt half filled with water. The neck is ſo contrived, as that a ſyringe, or condenſing pipe may be ſcrewed upon the tube; by means whereof a large quantity of air may be intruded through the tube into the water; out of which it will diſengage itſelf, and emerge into the vacant part of the veſſel, and lie over the ſurface of the water C D. See *Fig.* 30. *Hydraulicks*.

Now the water here contain'd, being thus preſſed by the air, which is, *e. gr.* twice as denſe as the

external air; and the elaſtick force of air being equal to its gravitating force, the effect will be the ſame as if the weight of the column of air over the ſurface of the water, were double that of the column preſſing in the tube; ſo that the water muſt of neceſſity ſpout up through the tube, with a force equal the exceſs of preſſure of the included, above that of the external air.

But if our *artifical fountain* is to play *by the preſſure of the water*, we muſt ſearch a reſervoir of water in a place conſiderably higher than that where the fountain is to be, (whether that reverſoir have been placed there by nature; or whether it have been raiſed for the purpoſe by a proper engine; as a pump, ſiphon, ſpiral ſcrew, or the like) having found ſuch reſervoir, we'll lay vertical tubes for the water to deſcend through; and to theſe vertical tubes, fit other horizontal ones under ground, to carry the water to the place where the fountain is to play. Laſtly, from theſe horizontal tubes, we'll erect other vertical ones, by way of adjutages, jets, or ſpouts; their altitude being much leſs than that of the tubes, whereby the water was carried to the horizontal ones. Then will the water, by the preſſure of the ſuperincumbent column, be ſpouted up at theſe jets; and that to the height or level of the water in the reſervoir, and thus howſoever any of the tubes be bent or incurvated.

Thus may water be ſpouted to any given height at pleaſure: the tubes may be ſo proportioned, as to yield any given quantity of water, in a given time: or ſeveral tubes of the ſame *fountain*, may be made to yield water in any given ratio; or laſtly, different tubes may project the water to different altitudes

Theſe aerial or aquatick *fountains*, may be applied in various manners; ſo as to exhibit various appearances; and from theſe alone ariſes the greateſt part of our artificial water-works, which ſo agreeably ſtrike the ſight, that the deſcription of ſome of them, muſt be very entertaining; therefore,

I'll begin by the deſcription of an *artificial fountain, which ſpouts the water in various directions.* Suppoſing, firſt, the vertical tube or ſpout in which the water raiſes to be I L (*Fig.* 31. *ibid.*) into this are to be fitted ſeveral other tubes; ſome horizontal, others oblique; ſome inclining, others reclining, as M N, O P, Q R, &c. Then all the water will retain the direction of the aperture through which it is ſpouted, that iſſuing through I, will riſe perpendicularly; and that through M N, O P Q R, will deſcribe arches of different magnitudes, and tending different ways.

Or thus; ſuppoſe the vertical tube M N, (*Fig.* 32. *ibid.*) through which the water riſes, to be ſtopped a-top, as in M; and inſtead of pipes or jets, let it be only perforated with little holes all round, or only half its ſurface, then will the water ſpin forth in all directions, through the little apertures, and to a diſtance proportional to the height of the fall of the water: and hence if the tube M N, be ſuppoſed the height of a man, and be furniſhed with an epiſtonium, or cock, at P; upon opening the cock, the ſpectators dreaming of no ſuch matter, will be covered with a ſhower, obſerving, however, that the diameter of the apertures through which the water is emitted, muſt be conſiderably leſs than thoſe tubes in which the water is brought; leſt the reſiſtance of the air, and other impediments, break the force of the water.

We'll exhibit next, a *fountain playing by the draught of the breath*; in ſuppoſing R S (*Fig.* 32. *ibid.*) to be a glaſs, or metalline ſphere, wherein is fitted a tube T V, having a little orifice in T, and reaching almoſt to V, the bottom of the ſphere; if now the air be ſucked out of the tube T V, and the orifice T be immediately immerged under cold water, the water will aſcend thro' the tube into the ſphere. Thus proceeding by repeated exſuctions till the veſſel be above half full of water, and then applying the mouth to T, and blowing air into the tube; upon removing the mouth, the water will ſpout forth. Or, if the ſphere be put into water, the air being thereby rarified, will make the water ſpout as before. This fountain is called *Pila Heronis*, or *Hero's ball*, from the name of its inventer.

To make a *fountain, the ſtream whereof riſes, and plays thro a braſs hall*; we muſt provide a hollow braſs ball B (*Fig* 33. *ibid.*) made of thin plate, that its weight may not be too great for the force of the water; and make the tube D E, through which the water riſes, exactly perpendicular to the horizon. Then the ball being laid in the bottom of the cup or baſon F, will be taken up in the ſtream, and ſuſtain'd at a conſiderable height, as B; alternately vibrating, or playing up and down. Hence as the figure of the ball contributes nothing to its repriprocal riſe and fall; any other body, not too heavy, may be ſubſtituted in lieu thereof, *e. gr.* a bird with its wings ſtretched forth.

It is neceſſary the ball, when on the deſcent, ſhould keep the ſame preciſe perpendicular, wherein it roſe, (ſince otherwiſe it would miſs the ſtream, and fall downright) and that ſuch a *fountain* ſhould only be played in a place free from wind.

For the conſtruction of a *fountain, which ſpouts water in the form of a ſhower*; to the tube wherein the

the water is to riſe, we muſt fit a ſpherical, or lenticular head, 1, 2, (*Fig*, 34. *ibid.*) made of a plate of metal, and perforated a top with a great number of little holes: the water riſing with vehemence towards 1, 2, will be there divided into innumerable little threads, and afterwards break, and diſperſe into the fineſt drops.

To make a *fountain, which ſpreads the water in form of a table cloth*; we muſt ſolder to the tube H I, (*Fig*. 35. *ibid.*) two ſpherical ſegments K L, almoſt touching each other; with a ſcrew M, to contract or amplify the interſtice or chink at pleaſure. Others chuſe to make a ſmooth, even cleft, in a ſpherical or lenticular head fitted upon the tube. The water ſpouting through the chink, or cleft, will expand itſelf in manner of a cloth.

Since water may be derived or conveyed by tubes in any ſituation, and always retains the direction of the apertures, *artificial fountains* may be made wherein the *water ſpouts out of the figures of men and other animals*; by incloſing tubes within the figures of men or other animals, having their orifices in thoſe parts, whence the waters are to ſpout forth.

From the principles hitherto laid down, it will be very eaſy to deduce whatever relates to the furniture of *fountains*; and the various forms water may be put into by their means; all depending on the magnitude, figure, and direction of the adjutages or apettures.

To make a *fountain, which, when it has done ſpouting, may be turned like an hour-glaſs*; we muſt provide two veſſels, P Q and R S (*Fig*. 36. *ibid.*) which ſhould be ſo much the bigger, as the *fountain* is to play the longer; and placed at ſo much the greater diſtance from each other T V, as the water is deſired to ſpout the higher. Then X Y Z, which is a crooked tube, muſt be furniſhed with a cock in Z; and A B C, another bent tube, furniſhed with a cock in B. In F G, are to be other leſſer tubes, open at both ends, and reaching near the bottom of the veſſel R S, and P Q, to which the tubes T V and Q S, are likewiſe to reach. If now the veſſel P Q be filled with water, it will deſcend through the tube I X, and upon opening the cock Z, will ſpout up near to the height of G: and after its fall again, will ſink through the little tube F, into the veſſel R S, and expel the air through the tube E D. At length, when all the water is emptied out of the veſſels P Q; by turning the machine upſide down, the veſſel R D will be the reſervoir, and make the water ſpout up thro' the cock Z. Hence if the veſſels P Q and R S, contain juſt as much water as will be ſpouted up in an hour's time, we ſhall have a ſpouting clepſydra, or water clock, which may be divided or graduated into quarters, minutes, *&c.*

To this treatiſe we ſhould add certain engines and inſtruments of modern invention, and great uſe.

ENGINE *for extinguiſhing fires*, a machine for raiſing a conſiderable quantity of water, in one continued ſtream, for the extinguiſhing accidental fires.

The beſt engine of this kind is that of Mr. *Newſham*, an engine-maker of *London*, which is ſo contrived that part of the men who work it, exert their ſtrength by treading, the very beſt way of working ſuch engines; the whole weight of the body being ſucceſſively thrown on the forces of the pumps, and every part of a man's ſtrength may be added to the weight, by means of horizontal pieces, to which he may apply his hands when treading. This is the reaſon why, with the ſame number of men, his engine will throw water farther, higher, and in greater quantities than any engines of the ſame ſize, hitherto contrived. See a perſpective view of the whole engine, ready for working, N° 1. in *Plate* facing *Huſbandry*.

The nature and effect of this engine will be eaſily underſtood from a perpendicular ſection of it repreſented *ibid.* N° 2.

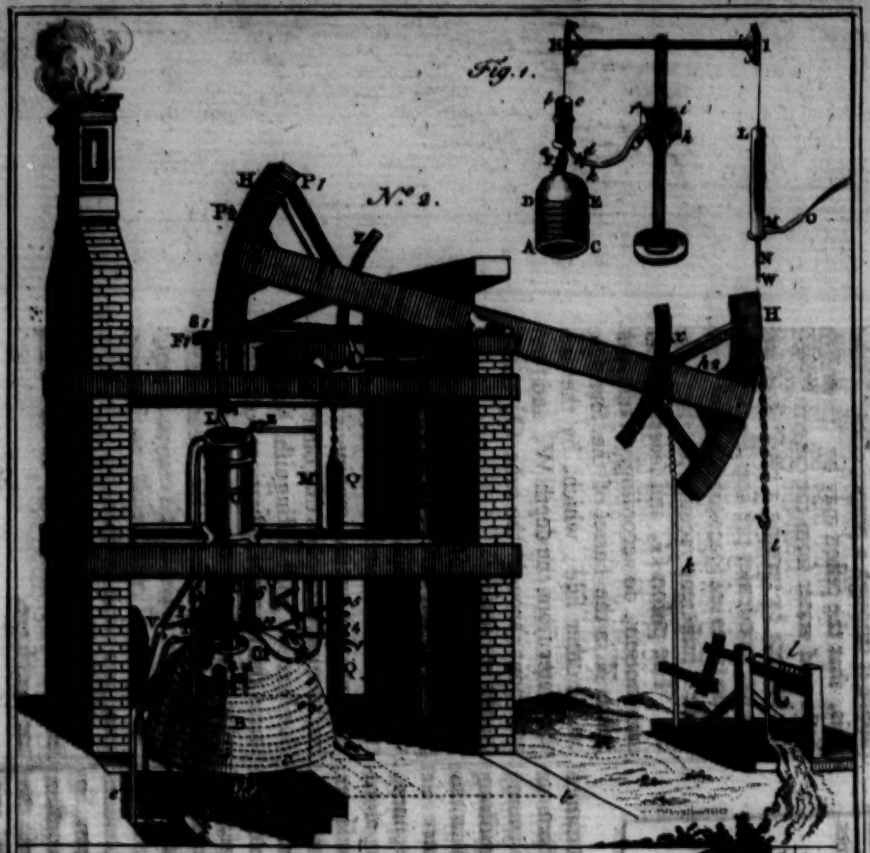
The water is raiſed by the preſſure of the atmoſphere, by the force of the piſtons, and by the ſpring of condenſed air, in the following manner: thus, when the piſton R is raiſed, a vacuum would be made in the barrel TV, did not the water follow it from the inferior canal E M (through the valve H) which riſes through the braſs tube E F, immerſed in the water of a veſſel, by the preſſure of the atmoſphere on the ſurface thereof. By the depreſſion of the piſton R, the water in the barrel TV is forced through the ſuperior canal ON, to enter by the valve I, into the air-veſſel *a b c d*; and the like being done alternately by the other barrel W X, and its piſton S, the air-veſſel is by this means continually filling with water, which greatly compreſſes the air above the ſurface of the water in the veſſel, and thereby proportionably augments its ſpring, which is at length ſo far increaſed, as to re-act with great force on the ſurface Y Z of the ſubjacent water; which aſcending through the ſmall tube *e f*, to the ſtop-cock *e g*, is there, upon turning the cock *p*, ſuffered to paſs through a pipe *h*, fixed to a ball and ſocket, from the orifice of which it iſſues with a great velocity, to a very great height or diſtance, in a ſmall continued ſtream, directed every way, or to any particular place, by means of the ball and ſocket.

The greateſt artifice of this engine is its contrivance to produce a continued ſtream, which is done by compreſſion, and the conſequent increaſed elaſticity

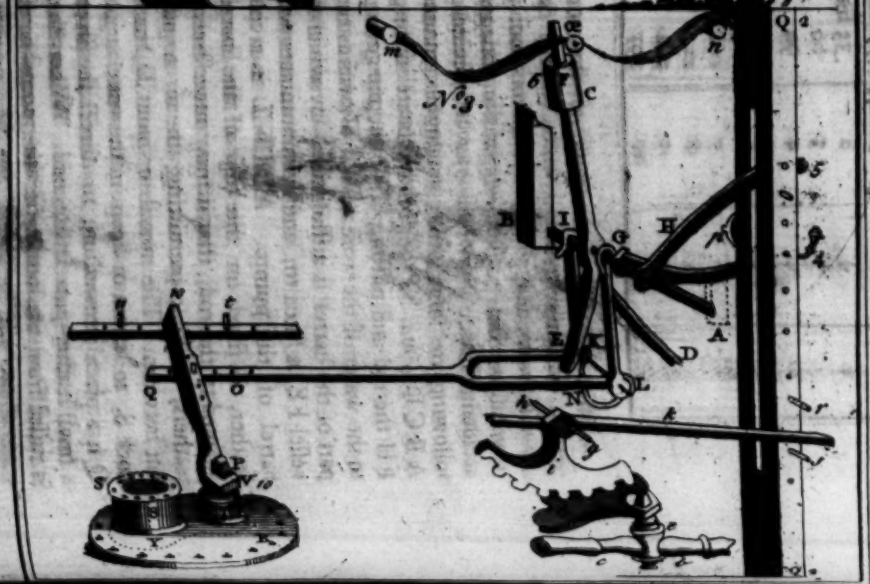
The STEAM ENGINE with its IMPROVEMENTS.

to face Hydraulics

Fig. 1.

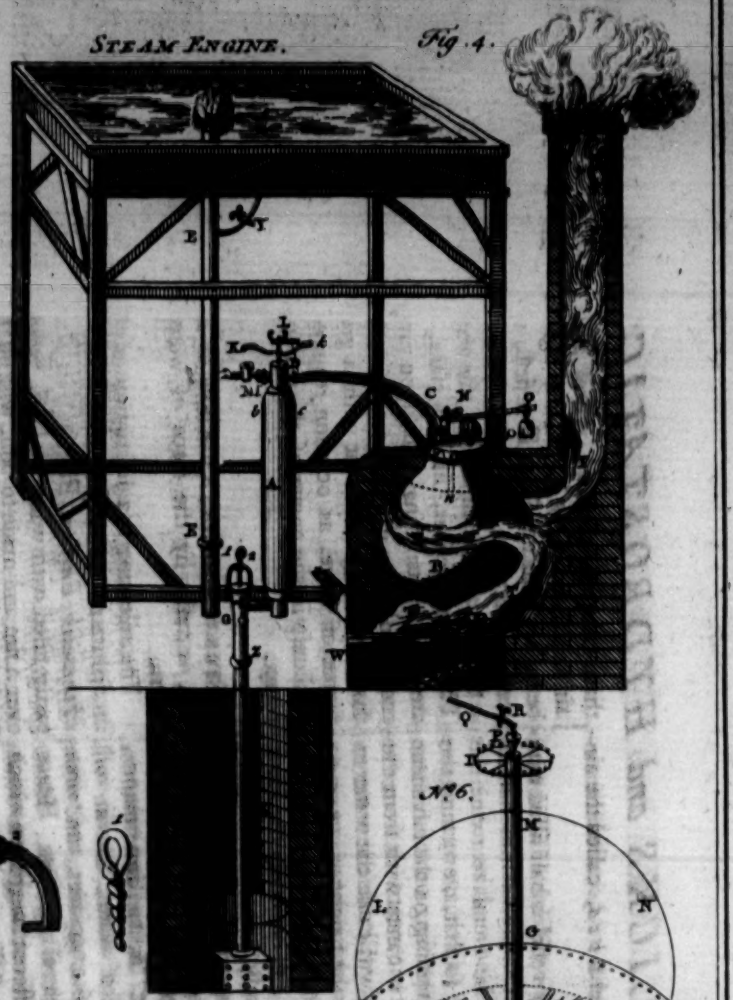


N°. 2.



N°. 3.

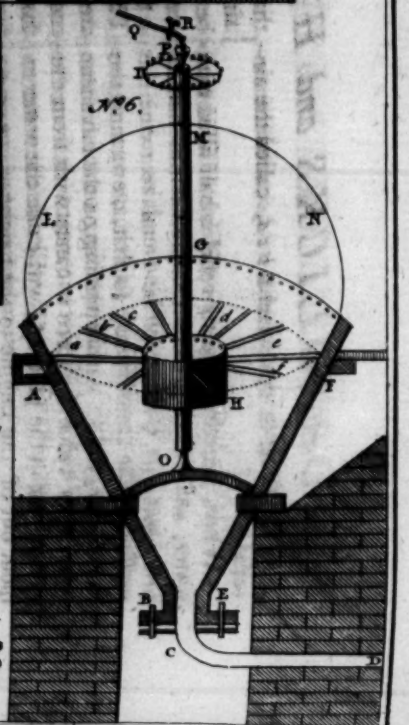
STEAM ENGINE. Fig. 4.



N°. 5.

From Water to fill the Boiler.

N°. 6.



ticity of the air in the barrel *a b c d*, called the air-veſſel.

When, therefore, the air veſſel is half filled with water, and the air thereby compreſſed into half its firſt ſpace, its ſpring will be equal to twice the preſſure of the atmoſphere; ſo that, on turning the ſtop cock *p*, the air within preſſing on the ſubjacent water with twice the force it meets with from the external air in the pipe *e f*, will cauſe the water to ſpout out of the engine to the height of 32 or 33 feet, if the friction be not too great.

When the air-veſſel is $\frac{2}{3}$ full of water, the ſpace which the air takes up is only $\frac{1}{3}$ of its firſt ſpace; whence its ſpring being three times as great as that of the common air, it will project the water with twice the force of the atmoſphere, or throw it to the height of 64 or 66 feet. In the ſame manner, when the air-veſſel is $\frac{3}{4}$ full of water, the air will project it to the height of 96 or 99 feet; and when $\frac{4}{5}$ full of water, to the height of 132 feet. Hence it is eaſy to calculate the different heights to which the water will riſe, as in the following table.

Height of the water.	Heighth of the compreſſed air.	Proportion of the air's ſpring.	Height to which the water will riſe.
$\frac{1}{2}$	$\frac{1}{2}$	2	33 feet.
$\frac{2}{3}$	$\frac{1}{3}$	3	66
$\frac{3}{4}$	$\frac{1}{4}$	4	99
$\frac{4}{5}$	$\frac{1}{5}$	5	132
$\frac{5}{6}$	$\frac{1}{6}$	6	165
$\frac{6}{7}$	$\frac{1}{7}$	7	198
$\frac{7}{8}$	$\frac{1}{8}$	8	231
$\frac{8}{9}$	$\frac{1}{9}$	9	264
$\frac{9}{10}$	$\frac{1}{10}$	10	297

As the air-veſſel is the cauſe of the continued ſtream, we may naturally infer, that if ſuch an air-veſſel were adapted to the common houſe pump, it would become a uſeful engine for extinguiſhing accidental fires. Now this may be effected in the following or ſome other analogous manner: let A B C D (*ibid.* N° 3.) be the barrel of the pump, P H the rod and piſton, C W the pipe going down to the water of the well at W. Towards the lower part of the barrel is a ſhot tube, by which the air-veſſel F E is fixed to, and communicates with the barrel of the pump. A M N L is a collar of leather, ſo fixed on the top of the barrel, and adapted to the rod, that it may move freely in the leathers, without permitting the air to paſs in or out between. The nozzle or ſpout D, has a ſtop-cock S, to let out or keep in the water at pleaſure. Q is a piece ſcrewed on, to direct the ſtream, by a ſmall leather-pipe at the end. When the piſton is raiſed from the bottom of the pump-barrel, the water above will be forced into the air-veſſel, and there compreſs the air; it will alſo compreſs the air on the top of the barrel, for the water will not be higher than the ſpout D at firſt, when the ſtop-cock is ſhut; but afterwards, as the air is confined, it will be compreſſed at top, the water riſing to I. This compreſſed air, in each place, will act upon the water by its ſpring, and, upon turning the ſtop-cock, will force it out in a continued ſtream thro' the pipe at Q, and that with a greater or leſſer degree of force, as occaſion requires, that being abſolutely in the power of the perſon working the pump.

STEAM-ENGINE, a machine to raiſe water by fire, or rather by the force of water turned into ſteam.

The following is a deſcription of this engine in its firſt ſtate, and original ſimplicity. A B C (Plate *Hydraulick Engines*, Fig. 1.) is a copper veſſel, partly filled with water to D E, which, being ſet over a fire and made to boil, will fill the upper part D B E with an elaſtic vapour, the ſufficient ſtrength whereof is known by its forcing open a valve at *e*: this heated elaſtic ſteam is, by turning a cock at F, let into the barrel *a b c d*, where, by its elaſtic force, it raiſes the piſton G, which drives the air above it through a proper clack at the top. After this, that the piſton may by its weight deſcend, a little cold water from the ciſtern *f g h i*, is let in at the bottom by turning a cock at *k*, which, in form of a jet, condenſes the hot ſteam in the barrel into 13000 times leſs ſpace than before it took up, which make a ſufficient vacuum for the piſton to deſcend in. The piſton G, and lever H I being thus put into motion, do accordingly raiſe and depreſs the piſton K in the barrel of the forcing pump L M, on the other ſide; which, by the pipe N, draws the water from the depth W, and forces it to riſe and ſpout through the tube O, continued to any height at pleaſure.

Thus is the *Steam-Engine* a very ſimple and plain machine, where a very powerful ſtroke for working of pumps is performed by only turning two cocks alternately; and yet a perſon who knows nothing of it, would imagine it to be very complex, by the number of parts that offer themſelves to view. But here we muſt diſtinguiſh between what performs the material operations of the engine, and what ſerves for conveniency and the juſt regulation of the ſaid operations; for not above the hundredth part of the power of this engine is employed to turn the cocks and regulate all the motions, as will appear from what follows.

The ſtructure of the *Steam-engine*, as uſed at preſent, is repreſented in N° 2. concerning which we are to obſerve.

1. That there may be always water in the ciſtern *g*, to injeſt into the ſteam to condenſe it, there is an arch *x*, fixed near the arch H, at the pump end, from whence another pump-rod *k*, with its piſton, draws water from a ſmall ciſtern near the mouth of the pit, ſupplied from the water raiſed at *p*, and forces it up the pipe *m m m*, to keep the injecting ciſtern *g* always full.

2. As the piſton C which moves up and down the cylinder ought to be air-tight, a ring of leather, or a piece of match, which lies upon its circumference next to the inſide of the cylinder, muſt be kept moiſt and ſwelled with water; this is ſupplied from the injecting ciſtern by a ſmall pipe *z*, always running down upon the piſton, but in a very ſmall quantity, if the work be well performed. L is a leaden cup, whoſe office is to hold the water that lies on the piſton, leſt it ſhould flow over when the piſton is arrived at its greateſt height in the cylinder, as W, at which time if the cup is too full, the water will run down the pipe L V, into the waſte-well at Y.

3. As the water, in the boiler B, muſt waſte by degrees, as it is conſtantly producing ſteam, and that ſteam continually let out for working the engine, there ought to be a conſtant ſupply of the water to boil: this is performed by means of the pipe F *f*, about three feet long, going down a foot under the ſurface of the water in the boiler, with a funnel F, at top, always open, and ſupplied by the pipe W, with water from the top of the ciſtern, which has the advantage of being always warm, and, therefore, not apt to check the boiling of the water in the copper.

4. That the boiler may not have the ſurface of the water too low (which would endanger burſting) or too high (which would not leave room enough for ſteam) there are two guage-pipes at G, one going a little below the ſurface of the water when at a proper height, and the other ſtanding a little above it: when every thing is right, the ſtop-cock of the ſhorter pipe being opened gives only ſteam, and that of the long one water; but if otherwiſe, both cocks will give ſteam when the ſurface is too low, and both give water when it is too high; and hence the cock which feeds the boiler at F may be opened to ſuch a degree as always to keep the ſurface of water to its due heighth.

5. As cold water is injected into the cylinder at every ſtroke, and as that water might in time fill the cylinder, and hinder the operation of the engine, there is a pipe coming from the bottom of the cylinder *d* T Y, called the eduction pipe, thro' which the water that has been injected, comes down every time the ſteam is let into the cylinder. This eduction pipe goes an inch or two under water in the waſte well Y, and having its end turned up is ſhut with a valve Y to keep out the air from preſſing up the pipe, but permitting the injected air coming the other way to be diſcharged; by which means the cylinder is kept empty.

6. Leſt the ſteam ſhould grow too ſtrong for the boiler, and burſt it, there is a valve fixed at *b* with a perpendicular wire ſtanding up from the middle of it, to put weights of lead upon, by which to examine the ſtrength of the ſteam puſhing againſt it from within. Thus the ſteam is known to be as ſtrong as the air, if it will raiſe up ſo much weight on the valve as is at the rate of 15 *lb.* to an inch ſquare; becauſe that is the weight of the air, nearly, on every inch ſquare. When the ſteam becomes ſtronger than what is required, it will lift up the valve and go out. This valve is called the puppet clack.

7. The ſteam is always in a fluctuating condition, yet never $\frac{1}{10}$ ſtronger or weaker than common air. For it has been found that the engine will work well, when there is the weight of one pound on every ſquare inch of the valve *b*. This ſhews that the ſteam is then $\frac{1}{15}$ part ſtronger than the common air. Now as the heighth of the feeding pipe from the funnel F to the ſurface of the water S *s* is not above three feet, and $3\frac{1}{2}$ feet of water is $\frac{1}{10}$ of the preſſure of air; if the ſteam were $\frac{1}{10}$ part ſtronger than air, it would puſh the water out at E; which ſince it does not do, it cannot be ſtronger than air, even in this caſe, where the regulator being ſhut, it is moſt of all confined.

8. When the regulator is open, the ſteam gives the piſton a puſh on the underſide, then occupying more ſpace, the ſteam comes to be a ballance only for the outward air, and ſo only ſuſtains the piſton; but the over weight of the pump-rods, at the contrary end of the beam *b* 2, draws up the piſton beyond C as far as W. The ſteam, then expanded ſo as to fill up all the cylinder, would not quite ſupport it, if it was not for the over weight above-mentioned. If this was not true, when the end *b* 2 is down as low as it can go, and reſts upon the beams that bear its center, the chain L H above the piſton would grow ſlack, and the piſton might ſometimes be puſhed out of the cylinder, which never happens.

Again, when firſt the ſteam is let into the cylinder, the injected water is puſhed out at the eduction pipe *d* T Y, and is all out of the cylinder by that time the piſton is got up to C. If then the ſteam was ſtronger than air, it would fly out at Y after the water, the valve Y not being loaded. If it were exactly equal to the ſtrength of the air, it would juſt drive all the water out at Y, but could not

not follow itſelf, the preſſure being equal on each ſide of the valve by ſuppoſition. If it be weaker than the air, it will not force all the water out of the pipe *d* TY, but the ſurface will ſtand, ſuppoſe at T, where the column of water T Y added to the ſtrength of the ſteam, is equal to the preſſure of the air. When the ſtream is $\frac{1}{10}$ weaker than the air, the height TY is equal $3\frac{1}{2}$ feet.

Now ſince the whole perpendicular diſtance from *d* to Y is but four feet, and the ſteam is always ſufficient to expel the water; it is plain it can never be more than $\frac{1}{10}$ part weaker than the air, when weakeſt.

9. As there is air in all the water injected, and that air cannot be taken out, or condenſed with the ſteam by the jet of cold water coming in at *n*, the whole operation would be diſturbed, and only a very imperfect vacuum made, were it not for the following contrivance.

We are to remember that when ſteam is become as ſtrong as air, it is above ſixteen times rarer; ſo that air will precipitate in ſteam, as quickſilver would in water. Therefore all the air extricated from the injected water, lies at the bottom of the cylinder, over the ſurface of ſo much of the injected water as is come down to *d n*. Now there is without the cylinder at 4, a little cup with a valve, and from under the valve, a pipe going laterally into the cylinder above its bottom to receive the air into the cup. When, therefore, the ſteam firſt ruſhes into the cylinder, and is a little ſtronger than the outward air, it will force the precipitated air to open the valve at 4, and make its eſcape; but the ſteam cannot follow, becauſe it is weaker than the external air, as the piſton, by aſcending, gives it room to expand. This valve from the noiſe it makes is called the ſnifting clack.

10. But amongſt the greateſt improvements of this engine, we may reckon that contrivance by which the engine itſelf is made to open and ſhut the regulator and injection-cock, and that more nicely than any perſon attending could poſſibly do it. For if the man who turns the regulator at E, and the injection-cock N, when the piſton is coming down, opens the regulator and lets in the ſteam too ſoon to raiſe the piſton again, the ſtroak will be ſhorter than it ought to be; and if he does not open the regulator ſoon enough, the piſton coming down with a prodigious force, will very probably ſtrike againſt the throat pipe D *d* at *d*, and cruſh it to pieces.

Likewiſe when the regulator is open, the ſteam going into the cylinder, and the piſton riſing, the ſtroke will not have its full length, if the ſteam is turned off, and the cold water injected too ſoon; and if injected too late, the ſteam may throw the piſton quite out of the cylinder's top at L.

To ptevent, therefore all ſuch accidents, there is fixed to an arch Z, at a proper diſtance from the arch P, a chain, from which hangs a perpendicular piece, or working beam QQ, which comes down quite to the floor, and goes through it in a hole which it fits very exactly. This piece has a long ſlit in it, and ſeveral pin holes and pins for the movement of ſeveral levers deſtined to the office of opening and ſhutting the cocks after the following manner,

11. Between two perpendicular pieces of wood on each ſide of P, there is a ſquare axis AB (*ibid.* N° 3.) which has upon it ſeveral iron pieces of the lever kind. The firſt is the piece CED called the Y, from its repreſenting that letter inverted by its two ſhanks, E and D; on the upper part is a weight F, to be raiſed higher and lower, and fixed as occaſion requires. This Y is fixed very faſt upon the ſaid iron axle A B.

12. From the axle hangs a ſort of an iron ſtirrup, IKLH, by its two hooks IG, and having on the lower part two holes K L, through which paſſes a long iron pin L K, and keyed in the ſame. When this pin is put in, it is alſo paſſed through the two holes in the ends E N of the horizontal fork or ſpanner E QN, joined at its end Q to the handle of the regulator V 10. From Q to O are ſeveral holes, by which the ſaid handle may be fixed to that part of the end which is moſt convenient.

13. Upon the axis A B is fixed at right angles to the Y an handle or lever G 4, which goes on the outſide of the piece QQ, and lies between the pins. Another handle is alſo faſtened upon the ſame axle, *viz.* H 5, and placed at half a right angle to the former G 4: this paſſes through the ſlit of the piece Q Q, lying on one of its pins. Hence we ſee that when the working beam goes up, its pin in the ſlit lifts up the ſpanner H 5, which turns about the axle ſo faſt, as to throw the Y with its weight F from C to 6, in which direction it would continue to move after it paſſed the perpendicular, were it not prevented by a ſtrap of leather fixed to it at *a*, and made faſt at the ends *m* and *n*, in ſuch manner as to allow the Y to vibrate backwards and forwards about a quarter of a circle, at equal diſtance on this ſide and that of the perpendicular.

14. As things are repreſented in the figure, the regulator is open, its plate TY being ſhewn on one ſide of the pipe S, which joins the cylinder and boiler. The piſton is now up, and alſo the working beam near its greateſt height, the pin in the ſlit has ſo far raiſed the ſpanner H 5, that the weight F on the head of the Y is brought ſo far from *n*, as to be paſt the perpendicular and ready to fall

over towards *m*, which when it does, it will by its ſhank E, ſtrike the iron pin K L with a ſmart blow, and drawing the fork O N horizontally towards the beam Q, will draw the end 10 of the regulator towards *t*, and thereby ſhut it, by ſlipping the plate Y under the holes of the throat-pipe S.

15. Immediately after the regulator is ſhut, the beam riſing a little higher with its pin *S* on the outſide upon the lower part, lifts up the end *i* of the handle of the injecting-cock, and opens it by the turning of the two parts with teeth. The jet immediately making a vacuum, the beam again deſcends, and the pin *r* depreſſing the handle *hi*, ſhuts the injection-cock; and the beam continuing to deſcend, the pin *p* bears down the handle G 4, and throwing back the Y, its ſhank D throws forward the fork N Q, and again opens the regulator to receive freſh ſteam. After this every thing returns as before, and thus is the engine moſt wonderfully contrived to work itſelf.

16. Many years after the engine had been made, as above deſcribed, it received another improvement of very great advantage, and that was, inſtead of feeding the boiler with warm water, from the top of the cylinder (*ibid Fig.* 3.) by the pipe W above, and F *f* below, they contrived to ſupply it with the ſcalding hot water which came out of the eduction-pipe *d* T Y, which now, inſtead of going into the waſte well at Y, was turned into the boiler on the top, and as the eduction-pipe before went out at the ſide of the cylinder, it was now inſerted in the bottom of it; and though the preſſure of the ſteam in the boiler be ſomewhat ſtronger than in the cylinder, yet the weight of water in the eduction-pipe being added to the force of ſteam in the cylinder will carry the water down continually, by overcoming the reſiſtance in the boiler.

This is the *lever-engine* with the improvements of Mr. *Newcomin* and others; but as Captain *Savary's*, or rather the Marquis of *Worceſter's*, is very cheap in reſpect of this machine, and as it is alſo applicable with great advantage when the heights to which the water is to be raiſed does not exceed 100 or 150 feet, we ſhall here ſubjoin a view of that engine, with the improvements of Dr. *Deſaguliers*.

The boiler B B (*Fig.* 4.) is a large copper body of a globular form, which will beſt of all withſtand the very great force of ſteam that in this caſe it neceſſary. Round the body of this boiler the fire and flame are conducted as ſhewn at T T T. It has a copper-cover ſcrewed on, which contains the ſteam pipe C D, and two gage-pipes *n*, *o*, which by turning their cocks, ſhew the height of the water within as in the other engine. On the ſame cover P is a valve, over which lies a ſteel-yard, with its weight Q to keep it down, the ſtrength of the vapour being this way moſt exactly eſtimated. For being in the nature of a lever of the third ſort, it is plain, if the beam of the lever be divided into ten equal parts, and the firſt of them being upon the middle of the valve, and the weight Q hangs at the 2d, 3d, 4th, *&c.* diviſions, that then the force of the ſteam which can raiſe up the valve will be 2, 3, 4, *&c.* times as great as the weight. If the area of the valve be a ſquare inch, and Q = 15 *lib.* hanging at the ſecond diviſion is raiſed by a ſteam puſhing up the valve, it will ſhew that the ſteam will then preſs with the force of two atmoſpheres, and ſo on to ten atmoſpheres; but great care muſt be then taken that the ſteam ſo very ſtrong burſt not the boiler to pieces.

The ſteam is carried from the boiler to a copper-veſſel A, by means of the pipe C D, and is let into it by turning the handle K of the ſteam-cock D I. The key of this cock is kept down by the ſcrew L, held up by the gibbet D L. The handle turned from K to *k* admits a paſſage to the ſteam into the copper-receiver A.

This receiver A communicates at bottom with the ſucking-pipe Z H going down to the water H in the well X, and above with the forcing-pipe E E, which goes up a little above the water of the reſervoir R, and between theſe pipes are two valves F and G both opening upwards.

The ſteam being let in upon the water of the receiver A, forces it up through the valve F, and the pipe E E to the reſervoir, and then the receiver is full of hot ſteam. This ſteam in the receiver is condenſed by a jet of cold water coming from the forcing-pipe by the ſmall pipe M I, being let in and ſhut off by the cock at M. The ſteam being condenſed by this jet will be reduced within a very ſmall ſpace, and ſo make a vacuum, upon which the water in the well will ruſh up the forcing-pipe to reſtore the equilibrium, and thus again fill the receiver A, the little air being compaſſed within a ſmall compaſs at the top above *b c*. That there may be always water in the force-pipe for the jet, there is a little pipe which brings the water to it from the reſervoir with the ſmall ſtop-cock Y, to ſhut it off upon occaſion.

The valves at F and G are examined at any time by unſcrewing the pin 1, to looſen the ſtrap 2, and let down the ſtanch 3, all which parts are ſhewn larger in the figures N°. 5. By the particular contrivance of the cock at D I, and its key, the water is made to paſs from the force-pipe to the boiler to ſupply the waſte in ſteam.

This is plainly ſhewn in the ſections of the cock and key, where 5 is the top of the key, 6 is a

hole on one side, which goes down to the bottom to convey the steam, or jet of water alternately to the receiver; 7 is a notch on the other side to take in the water from the force-pipe, and conduct it to the boiler B.

How this is done is easy to conceive from a view of the two sections of the cock and key, in two positions within it. The boiler may hold about five or six hogsheads, and the receiver one hogshead. It will work four or five hours without recruiting: about four strokes a minute will produce upwards of 200 hogsheads per hour. This steam makes a vacuum so effectually, as to raise water from the well to the height of twenty nine or thirty feet; and suppose the steam able to lift up the steel yard with its weight hanging on the 6th division, it will then be able to raise a column of water above fifty yards high, as being then six times stronger than the pressure of the atmosphere, as is easily understood from what has been said upon the *fire-engine*, the water being raised in a similar manner in both machines, there by the pressure of condensed elastic air, and here by the pressure of rarefied elastic steam.

In the philosophical transactions there is an account of an improvement made in the *steam-engine* by Mr. *Payne*, as follows. He has contrived two iron-pots or vessels of a conical form inverted as represented by A B E F N° 6.) on the upper part of which is fixed a globular copper-head, of about 5½ feet diameter, as LMN. Then there is placed on the inside a small machine H, called the dispenser, with spouts *a b c d e*, &c. round the sides fixed to it, and the bottom thereof rests on a center pin O. In this machine is fixed an upright tube G with holes at the bottom, and a funnel P on the top, to receive a spout of water from a conduit-pipe Q, by the stop cock R. Two or more of these vessels are placed in a reverberatory arch for conveying the intense heat of a strong fire, the flame whereof encompasses the iron-vessels, and keeps them in a red heat during the time of their use, at which time the cog-wheel I, being turned by proper machinery, whirls the dispenser about with great velocity, and causes the water in it to fly through the spouts against the sides of the red hot pots. By this means, the greatest part of the water is converted into vapour or elastic steam, which is conveyed by a common pipe and cock to the barrel of the engine to put the piston in motion, and the waste water is conveyed away at bottom by means of a pipe CD, with a valve at D to keep out the air.

In *Hydrostaticks* our modern philosophers have given us the following instruments,

The HYDROMETER, an instrument to measure the gravity, density, velocity, force, &c. of water and other fluids, is one of the most useful instruments of the philosophic kind; for tho' the *hydrostatic ballance* be the most general instrument for finding the specific gravities of all sorts of bodies, yet the *hydrometer* is best suited to find those of fluids in particular, both as to ease and expedition.

This instrument should be made of copper; for ivory imbibes spirituous liquors, and thereby alters its gravity; and glass is apt to break. The most simple kind, used for finding the strength of spirits, consists of a copper-ball B *b* (plate *Hydrostatick Instruments*, *Fig.* 1. N° 1.) with a brass wire, A B, ¼ of an inch thick, soldered into it. The upper part of this wire being filed flat on one side, is marked proof at *m*, because it sinks exactly to this mark in proof-spirits. There are other two marks at A and B, to shew whether the liquor be $\frac{1}{10}$ above or below proof, according as the hydrometer sinks to A, or emerges to B, when a brass weight as C or K has been screwed on at the bottom *c*. There are also weights to be screwed on, for shewing the specific gravities of fluids quite to common water. The round part of the wire above the ball, may be marked so as to represent river-water when it sinks to R W, (*ibid.* N° 2.) the weight which fits the instrument for river-water being screwed on at *c*: also when put into spring-water, mineral-water, sea-water, and water of salt-springs, it will emerge or rise gradually to the marks S P, M I, S E, S A; and on the contrary, when put into bristol-water, rain-water, port-wine, and mountain-wine, it will successively sink to the marks *b r*, *v a*, *p o*, *m e*.

Another kind, which serves to distinguish the specific differences of fluids to great nicety, consists of a large hollow ball B. (*ibid.* N° 3.) with a smaller ball *b* under it, partly filled with quick-silver or small shot, and screwed on to the lower part of the former, in order to render it but little specifically lighter than water: it has also a small short neck at C, into which is screwed the graduated brass-wire A C, which by its weight causes the body of the instrument to descend in the fluid, with part of the stem.

When this instrument is swimming in the liquor, contained in the jar I L M K, the part of the fluid, displaced by it, will be equal in bulk to the part of the instrument under water, and equal in weight to that of the whole instrument. Suppose the weight of the whole were 4000 grains, then it is evident we can by this means compare together the different bulks of 4000 grains of various

rious ſorts of fluids. For if the weight A, be ſuch as ſhall cauſe the aræometer to ſink in rain-water, till its ſurface comes to the middle point of the ſtem 20, and if, after this, it be immerſed in common ſpring-water, and the ſurface is obſerved to ſtand $\frac{1}{7}$ of an inch below the middle point 20; it is evident that the ſame weight of each water differs in bulk only by the magnitude of $\frac{1}{70}$ of an inch in the ſtem.

Now ſuppoſe the ſtem were ten inches long, and weighed 100 grains, then every tenth of an inch would be one grain weight; and ſince the ſtem of braſs, and braſs is about eight times heavier than water, the ſame bulk of water will be equal to $\frac{1}{8}$ of a grain; and conſequently to the $\frac{1}{8}$ of $\frac{1}{1000}$ part, that is, a 32000th part of the whole bulk, which is a degree of exactneſs as great as can be deſired. Yet the inſtrument is capable of ſtill greater exactneſs, by making the ſtem or neck conſiſt of a flat thin ſlip of braſs, inſtead of one that is round or cylindrical: by this means we increaſe the ſurface, which is the moſt requiſite thing; and diminiſh the ſolidity, by which the inſtrument is rendered more exact.

In order to adapt this inſtrument to all ſorts of uſes, there ought to be two different ſtems to ſcrew on and off in a ſmall hole at *a*. One ſtem ſhould be ſuch a nice thin ſlip of braſs, or rather of ſteel, like a watch-ſpring ſet ſtrait, as we have juſt mentioned, on one ſide of which ought to be the ſeveral marks or diviſions, to which it will ſink in various ſorts of waters, as rain-water, river-water, ſpring-water, ſea-water, ſalt ſpring-water, *&c.* And on the other ſide you mark the diviſion to which it ſinks in various lighter fluids, as hot bath-water, *Briſtol* water, *Lincomb*-water, *Chelten*-water, *port* wine, *mountain*, *Madeira*, and various other ſorts of wine. But in this caſe the weight A on the top muſt be a little leſs than before, when it was uſed for the heavier waters.

But in caſe of trying the ſtrength of ſpirituous liquors, a common cylindric ſtem will do beſt, becauſe of its ſtrength and ſteadineſs; and this ought to be ſo contrived, that when immerſed in what is called *proof-ſpirit*, the ſurface of the ſpirit may be upon the middle point 20; which is eaſily done by duly adjuſting the ſmall weight A on the top, and making the ſtem of ſuch a length, that when immerſed in water, it may juſt cover the ball, and riſe to *a*; but, when immerſed in pure ſpirit, it may riſe to the top at A; then by dividing the upper and lower parts *a* 20, A 20, into ten equal parts each; when the inſtrument is immerſed in any ſort of ſpirituous liquor, it will immediately ſhew how much it is above or below proof.

This *proof-ſpirit* conſiſts of half water and half alcohol, or pure ſpirit, that is, ſuch as when poured upon gunpowder, and ſet on fire, will burn all away, and permit the powder to take fire, which it will, and flaſh as in the open air. But if the ſpirit be not ſo highly rectified, there will remain ſome phlegm or water, which will make the powder wet, and unfit to take fire. This *proof-ſpirit* of any kind, weighs ſeven pounds twelve ounces per gallon.

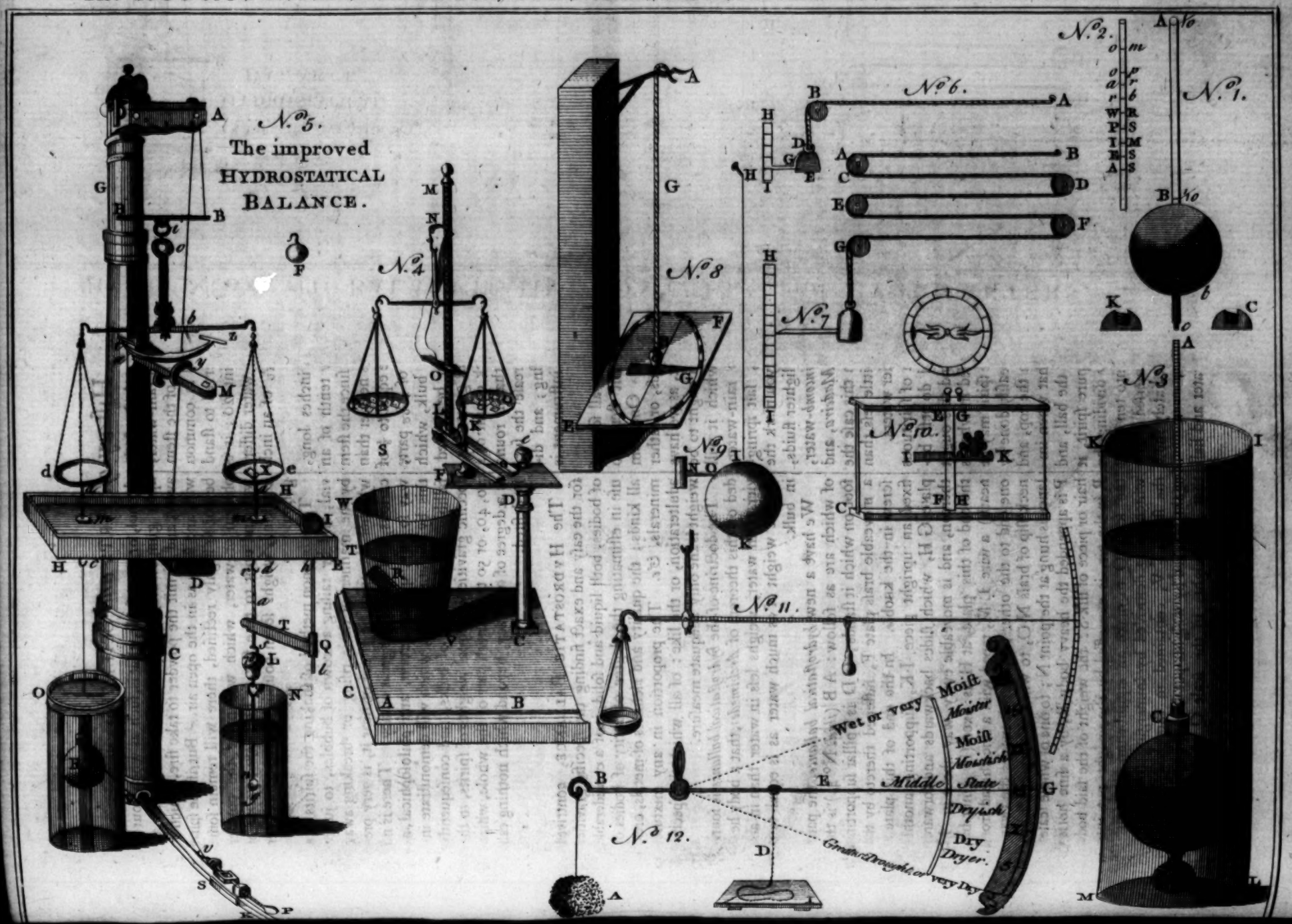
The common method of ſhaking the ſpirits in a vial, and by raiſing a crown of bubbles, to judge by the manner of their riſing or breaking away whether the ſpirit be proof or near it, is very precarious, and capable of great fallacy. There is no way ſo eaſy, quick, certain, and philoſophical, as this by the aræometer, which will demonſtrate infallibly the difference of bulks, and conſequently ſpecific gravities, in equal weights of ſpirits, to the 30, 40, or 50 thouſandth part of the whole, which is a degree of accuracy, beyond which nothing can be deſired.

The Hydrostatic Ballance, contrived for the eaſy and exact finding the ſpecific gravities of bodies, both liquid and ſolid, is of a conſiderable uſe in eſtimating the degree of purity of bodies of all kinds; the quality and richneſs of metals, ores, minerals, *&c.* The proportion in any mixture, adulteration, or the like: of all which the ſpecific weight is the only adequate meaſure.

The doctrine of the *hydroſtatical ballance* is founded on this theorem of *Archimedes*, that a body heavier than water, weighs leſs in water than in air, by the weight of as much water as is equal to it in bulk.

We have a new *hydroſtatical ballance*, the parts of which are as follow: A B (*ibid.* N° 4.) is the foot on which it ſtands; C D is a pillar ſupporting a moveable braſs plate F, faſtened thereto by the ſcrew in the knob *e*. In the end of this plate is fixed an upright piece I K, ſupporting another plate G H, which ſlides backwards and forwards thereon, and is moveable every way about it. In the end of this plate, at H, is fixed (by a nut beneath) a wire L M, taped with a fine thread from one end to the other; upon this moves the ſwan-neck ſlip of braſs N O, to which a very exact ballance is hung at the point N; to one of whoſe ſcales P is appended the heavy body R, by a fine horſe-hair or piece of ſilk S: the weight of the ſaid body R in the air, is expreſſed by the weight put into the ſcale Q to make an equilibrium therewith, which being deſtroyed by immerging the ſolid in the fluid T V, contained in the glaſs W V, is again reſtored by weights put into the ſcale P. So that the weights in the ſcale Q compared with

The HYDROSTATIC BALANCE, HYDROMETERS and HYGROMETERS.



thoſe in the ſcale P, ſhew at once the ſpecific gravity of the ſolid R to that of the fluid T V.

The ſpecific gravity of fluids is readily determined by weighing one and the ſame ſolid body in them ſeverally; for ſince we ſuppoſe the ballance in equilibrio with the body ſuſpended in the air, the equilibrium will be deſtroyed when the ſolid is immerſed in the fluid, and muſt be then reſtored by weights put into that ſcale, to which the body is appended. Theſe weights will ſeverally expreſs the gravities of an equal bulk of the reſpective fluids; and conſequently they may be thus compared with each other, or all of them with the gravity of common water, as uſual, and diſpoſed in a proper table; making water 1.000,

In the ſame manner, if divers ſolids are firſt weighed in air, and then afterwards immerſed in the ſame fluid, as water; for inſtance, the equilibrium will be deſtroyed; which will be reſtored, as before, by putting in ſo much weight as is equal to the weight of the ſame bulk of water: the gravity, therefore, of every ſolid is thus compared with water, and conſequently with each other.

But in this, and many other caſes, it is required to be very exact in weighing bodies, even beyond what is attainable by the niceſt mechaniſm of this inſtrument. We ſhall therefore give the reader an account of an improvement of the common ballance in this reſpect; and it is the more pertinent in this place, as this inſtrument ſerves equally for exactneſs in common, as in *hydroſtatical* matters.

The figure of the machine repreſents the ballance in its hydroſtatic uſe, (*ibid.* N° 5.) We ſhall firſt deſcribe the machine, then ſhew the new contrived artifice for exactneſs; and laſtly, give an inſtance of its univerſal uſe. V C G is the ſtand or pillar fixed in the table; From the top at A hangs, by two ſilken ſtrings, the horizontal piece or bar B B; from which is ſuſpended, by a ring at *i*, the fine beam of a ballance *b*, which is kept from deſcending too low on either ſide by the gentle ſpringing piece *t x y z*, fixed on the ſupporter M. The harneſs is annulated at *o*, to ſhew diſtinctly the perpendicular poſition of the examen, by the ſmall pointed index fixed above it.

The ſtrings by which the ballance is ſuſpended paſſing over two pullies, one on each ſide the piece at A, go down to the bottom on the other ſide, and are hung over the hook at *v*; which hook by means of a ſcrew P, is moveable about 1 ¼ inches backwards and forwards, and therefore the ballance may be raiſed or depreſſed ſo much. But if a greater elevation or depreſſion be required, the ſliding piece S, which carries the ſcrew P, is readily moved to any part of the ſquare braſs rod V K, and fixed by means of a ſcrew.

The motion of the ballance being thus provided for, the reſt of the apparatus is as follows: H H is a ſmall table fixed upon a piece D, under the ſcales *d* and *e*, and is moveable up and down in a long ſlit in the pillar above C, and faſtened at any part with a ſcrew behind. At the point in the middle of the bottom of each ſcale is hung by a fine hook a braſs-wire *a d*, *a e*. Theſe paſs through two holes *m*, *m* in the table; and to the wire *a d* is ſuſpended a curious cylindric wire *r s*, perforated at each end for that purpoſe. This wire *r s* is covered with graduated by equal diviſions, and is about five inches long;

In the cornet of the table at E, is fixed a braſs-tube in which a round wire *b l* is ſo adapted as to move neither too hard nor too freely by its flat head *l*. Upon the lower part of this moves another tube Q, which has friction enough to cauſe it to remain in any poſition required; to this is fixed an index T, moving horizontally when the wire *b l* is turned about, and therefore may be eaſily ſet to the graduated wire *r s*.

To the lower end of the wire *r s* hangs a weight L, and to that a wire *p n* with a ſmall braſs ball *g*, about ¼ of an inch in diameter. On the other ſide to the wire *a e*, hangs a large glaſs bubble R by a horſe-hair. Let us at preſent ſuppoſe the weight L taken away, and the wire *p n* ſuſpended from S: and on the other ſide let the bubble R be taken away, and the weight F ſuſpended in its room at *e*. This weight F we ſuppoſe to be ſuch as will keep in equilibrio with the ſeveral parts appended to the other ſcale, at the ſame time that the middle point of the wire *p n* is in the ſurface of the water in the veſſel N. The wire *p n* is to be of ſuch a ſize, that the length of one inch ſhall weigh four grains. Hence it is evident, ſince braſs is eight times heavier than water, that for every inch the wire ſinks in the water, it will become half a grain lighter, and half a grain heavier for every inch it riſes out of the water: conſequently, by ſinking two inches below the middle point, or raiſing two inches above it, the wire will become one grain lighter or heavier. And therefore, if when the middle point is at the ſurface of the water in equilibrio, the index T be ſet to the middle point *a* of the graduated wire *r s*, and the diſtance on each ſide *a r* and *a s* contains a hundred equal parts; then, when in weighing bodies the weight is deſired to the hundredth part of a grain, it may be eaſily had by proceeding in the following manner.

Let the body to be weighed be placed in the ſcale *d*, and put the weight X in the ſcale *e*; and let this be ſo determined, that one grain more ſhall be too much, and one grain leſs too little. Then the ballance being gently moved up or down by the

ſcrew

ſcrew P, till the equilibrium be nicely ſhewn at *o*; and then if the index T be at the middle point *a* of the wire *r s*, it ſhews that the weights put into the ſcale *e*, are juſt equal to the weight of the body. By this method we find the abſolute weight of the body; the relative weight is found by weighing it *hydroſtatically* in water, as follows.

Inſtead of putting the body into the ſcale *e*, as before, let it be appended with the weight F at the hook *e*, by a horſe-hair as at R, ſuppoſing the veſſel of water O were away; then the equilibrium being made, the index T ſtanding between *a* and *r*, at the 36th diviſion, ſhews the weight of the body put in 1095.36 grains. As it thus hangs, let it be immerſed in the water of the veſſel O, and it will become lighter by much; the ſcale *e* will deſcend till the beam of the ballance reſts on the ſupporter *z*. Then ſuppoſe 100 grains put into the ſcale *d* reſtores the equilibrium preciſely, ſo that the index T ſtands at the 36th diviſion above *a*; it is plain the weight of an equal bulk of water would, in this caſe, be exactly 100 grains.

After a like manner may this ballance be applied to find the ſpecific gravities of fluids, which will not be difficult from what has been ſaid.

The Hygrometer is a machine, or inſtrument whereby to meaſure the degrees of drineſs, or moiſture of the air, or rather of the atmoſphere.

There are divers ſorts of hygrometers; for whatever body either ſwells or ſhrinks, by drineſs or moiſture, is capable of being formed into an hygrometer. Such are woods of moſt kinds, particularly aſh, deal, poplar, *&c.* Such alſo is cat-gut, the beard of a wild oat, *&c.* Stretch an hempen-cord or lute-ſtring, as A B. (*ibid.* N° 6.) along a wall, bringing it over a pulley, B; and to the other end D, fix a weight E; into which fit an index G. On the ſame wall fit a plate of metal H I, divided into any number of equal parts, and the hygrometer is compleat. For it is known from experience that moiſture ſenſibly ſhortens the length of cords or fiddle-ſtrings; and that as the moiſture evaporates, they return to their former length. The weight, therefore in the preſent caſe, upon an increaſe of the moiſture of the air, will aſcend; and upon a diminution of the ſame, it will deſcend.

Hence, as the index G will ſhew the ſpaces of aſcent and deſcent; and thoſe ſpaces are equal to the increments and decrements of the length of cord, or gut, A B D; the inſtrument will diſcover whether the air be more or leſs humid now, than it was at another given time.

But if a more ſenſible and accurate hydrometer be required, ſtrain a whip-cord or fiddle-ſtring, over ſeveral pullies B, C, D, E, F, and G. (*ibid.* N° 7.) and proceed as in the former example. Nor does it matter whether the ſeveral parts of the cord A B, B C, C D, *&c.* be parallel to the horizon as expreſſed in the figure or perpendicular to the ſame.

The advantage of this above the former hygrometer, is, that we have a greater length of cord in the ſame compaſs; and conſequently greater contraction or dilatation.

Another method of conſtruction, which is more ſimple, is thus. Faſten a hempen-cord or fiddle-ſtring, A B, (*ibid.* N° 8.) to an iron hook; and let the other end B, deſcend upon the middle of a horizontal board, or table, E F; near B, hang a leaden weight or ball of a pound, C, and fit an index C G. Laſtly, from the center B deſcribe a circle, which divide into any number of equal parts. Or, inſtead of the table or board, draw two concentric circles on the ball K from I. (N° 9.) and divide them into any number of equal parts, and fix an index N O, to any proper ſupport N. So that it may almoſt touch the diviſions of the ball. Here the cord or gut twiſting or untwiſting will ſhew the change of moiſture, *&c.* by the ſucceſſive application of the index to the diviſions of the circle.

Or thus: provide two wooden frames, A B and C D. (N° 10.) with grooves therein; and between theſe grooves fit two thin leaves of aſh, A E F C, and G B D H, ſo as they may eaſily ſlide either way. At the extremes of the frames A, B, C, D, confine the leaves with nails, leaving between them the ſpace E G H F, about an inch wide. On I faſten a ſlip of braſs dented, I K; and in L a little dented wheel, upon whoſe axis, on the other ſide of the machine an index is to be put. Laſtly, from the center of the axis, on the ſame ſide, draw a circle, and divide it into any number of equal parts.

Now, it is found from experience, that aſhen wood readily imbibes the moiſture of the air, and ſwells therewith; and as that moiſture ſlackens, ſhrinks again; upon any increaſe of the moiſture of the air, the two leaves A F and B H growing turgid, will approach nearer each other: and, again, as the moiſture abates, they will ſhrink, and again recede. Hence, as the diſtance can neither be increaſed nor diminiſhed without turning the wheel L, the index will point out the changes in reſpect of humidity, or ſiccity.

All the hygrometers above deſcribed become by degrees leſs and leſs accurate, and at length undergo no ſenſible alteration at all from the humidity of the air.

The

The following is much more lasting. Take a nice ballance (*ibid.* N° 11.) and place in it a sponge, or other body, which easily imbibes moisture; and let it be in equilibrio, with a weight hung at the other end of the beam. Now if the air become moist, the sponge becoming heavier, will preponderate; if dry, the sponge will be raised up. This ballance may be contrived two ways; be either having the pin in the middle of the beam, with a slender tongue a foot and a half long, pointing to the divisions on an arched plate fitted to it; or the other extremity of the beam may be made so long as to describe a large arch on a board placed for the purpose, as is represented in the figure.

To prepare the sponge, it may be necessary to wash it in water; and when dry again, in water or vinegar, wherein sal ammoniac, or salt of tartar, has been dissolved, and let it dry again, then it is fit to be used.

In the last mentioned hygrometer, Mr. *Gould*, in the *Philosophical Transactions*, instead of a sponge, recommends oil of vitriol, which is found to grow sensibly lighter or heavier, in proportion to the lesser or greater quantity of moisture it imbibes from the air; so that being satiated in the moistest weather, it afterwards retains or loses its acquired weight, as the air proves more or less moist. The alteration in this liquor is so great, that in the space of fifty-seven days, it has been known to change its weight from three drachms to nine; and has shifted an index or tongue of a ballance thirty degrees. A single grain, after its full increase, has varied its equilibrium so sensibly, that the tongue of a ballance, only an inch and a half long, has described an arch one third of an inch in compass, (which arch would have been almost three inches if the tongue had been one foot) even with so small a quantity of liquor; consequently, if more liquor, expanded under a large surface, were used, a pair of scales might afford as nice an hygrometer as any kind yet invented. The same author suggests, that oil of sulphur per campanum, or oil of tartar per deliquium, or the liquor of fixed nitre, might be substituted in lieu of the oil of vitriol.

But among all the inventions the following seems best calculated both for dispatch and accuracy. A (*ibid.* N° 12.) represents a thin piece of sponge, so cut as to contain as large a superficies as possible. This hangs by a fine thread of silk, upon the beam B, and is exactly ballanced from another thread of silk at D, strung with the smallest lead shot, at equal distances, and so adjusted as to cause the index E to point at G, in the middle of the graduated arch F G H, when the air is in a middle state between the greatest moisture and the greatest dryness. I, shews a little table or shelf for that part of the silk and shot which is not suspended to rest upon.

JAPANNING.

JAPANNING, is the art of imitating the *Japanese* in *varnishing* and *drawing* figures on wood and other materials.

The colours used in this art for a fair *red*, are the *Spanish* vermilion, with a fourth part of *Venice* lacquer; though *carmine* is far preferable. For *blue*, *ultramarine*, and only twice as much varnish as colours; the *Prussian* blue has the same effect, and is not so chargeable. The *black* is made of ivory calcined between two crucibles. *Green* is seldom used in *japanning*, because it is difficult to make it fair and lively.

The *varnish* is made by taking a pint of *spirit of wine*, well deflegmated, and four ounces of *gum lacca*, which after it has been broke from the sticks and rubbish, and roughly bruised in a mortar, must be tied up in a bag of coarse linen, together with a little *Castile* soap, and put to steep in spring water for the space of twelve hours. This done, all the tincture must be rubbed out, adding to it a little *allum*, and reserving it apart: then must be added as much *mastic* and *white amber*, distilled in a matrass, with spirit of wine, by a two days digestion, frequently stirring it, that it do not stick to the glass; then straining and pressing it out into another vessel.

This done, the wood to be *japanned* must be covered with a layer of this varnish, till it be sufficiently drenched with it; then taking some of the colours the figures are to be of, it must be incorporated with seven times as much of the varnish, and applied with a pencil, going over each part three several times, each a quarter of an hour after the other: two hours after this it must be polished with a pestle or *Dutch* reeds.

What they call *night japanning*, is performed by applying three or four layers, with the colours first; then two of pure varnish uncoloured. Before it is dry, some venturine or gold wire reduced to powder, must be sifted over it; then covering it over with as many layers of pure varnish to render it like polished glass; and lastly, rubbing it over with tripoli, oil of olive, or hatters felt.

JEWELLER.

THE art of the *Jeweller* consists in setting diamonds, rubies, emeralds, and other precious stones, in gold, silver, or other metals, that they may appear with a full lustre, and hide their defects, as much as possible.

To heighten the lustre of a stone, they put commonly under it a leaf of the same colour of the stone, but livelier, which they call *foyl*.

To proceed in this operation, they begin by putting the ring, or other piece which is to be set with jewels, into cement; then they put the foyl, and over it the stone, which they fasten in the callet by approaching the metal near it, with their setting tool as close as possible, without breaking or scratching the stone; this done, they file and polish the metal.

This art must be very antient, and ought to be considered as having been invented in heaven, since God, *Exodus* xxviii. gives these directions for the breast-plate, ver. 17. *And thou shalt set in it settings of stones.*

LAPIDARY.

LAPIDARY cuts precious stones.—There are various machines used in the cutting of precious stones, according to the quality of the matter to be cut.

To cut and form a *diamond*, the *lapidaries* use a wheel of soft steel, turned by a kind of mill, with diamond dust, tempered in oil of olives; which serves likewise to polish it.

From the different manner of cutting them, *diamonds* borrow their different appellations of *roses*, *brilliants*, *table*, &c.

To give to a *diamond* the form of a rose, it must be made quite flat underneath, and its upper part cut into divers little faces, usually triangles, the uppermost whereof must terminate in a point.

A *brilliant diamond* is formed by cutting it in faces both a-top and bottom, making its table, or principal face a-top, flat.

The *table diamond* is that which has a large square face a-top.

The whole secret of the art consists in observing a just symmetry in the formation of the faces, whereby the lustre of the stone is more or less heightened; for if they are too large, that lustre is dull or languishing, and if too small, it is too confuse, and the stone does not play, by so agreeable a variety of colours. It consists likewise in the polishing, that there should be neither clouds, flaws, nor scratches on the stone.

Oriental *rubies*, *saphires*, and *topazes* are cut, and formed on a copper wheel with oil of olive, and diamond-dust: they are polished on another copper wheel with tripoly and water.

Emerald, *hyacinths*, *amethysts*, *garnets*, *agates*, and other stones less hard, are cut on a leaden wheel with smalt and water, and polished on a tin wheel with tripoly.

These wheels are fixed on a table, with a handle to them, by means whereof the artist turns the wheel round with his left-hand, holding with the right the stone upon it, having before besmeared it over with his composition. The stone is fixed with cement, at the end of a sort of scewer, that the artist may easier lay hold of it.

Turquois, of the old and new rock, *lapis*, *girasole*, and *opal*, are cut and polished on a wooden wheel with tripoly.

LAPIDARY is also used for one skilled in the nature, kinds, &c. of precious stones, or a merchant who deals in them.

A rough *diamond*, must be chosen uniform, of a good shape, transparent, not quite white, and free of flaws and shivers. Black, rugged, dirty, flawey, veiny stones, and all such as are not fit for cutting, are most commonly pounded in a steel mortar for that purpose; and when pulverized they serve to saw, cut, and polish the rest.

The goodness of *diamonds* consists in their water, or colour, lustre and weight. The most perfect colour, and most esteemed at present, is the white. The yellow has been a long while in vogue, and our ancestors esteemed a black cast, which they imagined contributed much to heighten the lustre of the stone.

The water called *cælestis* is the worth of all, and yet is somewhat difficult to discover in a rough *diamond*. The only infallible way is to examine it in the shade of some tufted tree.

In *Europe* the *Lapidaries* examine the goodness of their rough *diamonds*, their water, points, &c. by day-

day light; in the *Indies* they do it by night; in order to which, a hole is made in the wall a foot ſquare, and therein a lamp placed with a thick wick, by the light whereof they judge of the ſtone, holding it in their fingers.

As to their diſtinguiſhing of *diamonds* from other ſtones, Dr. *Wall* in the *Philoſophical Tranſactions*, ſeems to have found an infallible method. A *diamond* with an eaſy ſlight friction in the dark, with any ſoft animal ſubſtance, as the finger, woollen, ſilk, *&c.* appears luminous in its whole body: nay, if you keep rubbing for ſome time, and then expoſe it to the eye, it will remain ſo for ſome time. If the ſun be 18 degrees below the horizon, holding up a piece of bays, or flannel ſtretched tight between both hands, at ſome diſtance from the eye; and another rubbing the other ſide of the bays or flannel pretty briſkly with a *diamond*, the light is much more vivid and pleaſant than any other way. But what Dr. *Wall* judges moſt ſurprizing is, that a *diamond* being expoſed to the open air in view of the ſky, gives almoſt the ſame light of itſelf, without rubbing, as if rubbed in a dark room; but, if in the open air you put the hand, or any thing a little over it, to prevent its immediate communication with the ſky, it gives no light, which is a diſtinguiſhing criterion of a diamond.

The following is a rate, or manner of eſtimating the value of *diamonds*, drawn up by a perſon well verſed in ſuch matters, and which for its curioſity, as well as the uſe it may be of to perſons who deal in *diamonds*, we judge will not be unacceptable.

TABLE *of* DIAMONDS.

Dutch Cut.

A diamond *weighing one grain is worth from,*

Grains.	*l.*	*s.*		*l.*	*s.*	*Ster.*
1 —	1	0	to	1	1	
1½ —	1	16	to	1	17	
2 —	2	15	to	3	0	
2½ —	3	12	to	3	15	
3 —	4	15	to	5	0	
4 —	7	17	to	8	0	
5 —	15	0	to	15	15	
6 —	22	0	to	25	0	
7 —	30	0	to	34	0	
8 —	42	0	to	45	0	
9 —	60	0				
10 —	75	0				
12 —	112	0	to	120	0	
15 —	187	0	to	220		
19 —	330	0	to	380	0	
24 —	450	0				
30 —	700	0	to	735	0	
40 —	1500	0	to	1800	0	
50 —	3500	0	to	4500	0	
60 —	4500	0	to	5620	0	

It muſt be obſerved, however, that defects in the water, or ſhape, red, or black ſpots, ſhivers, and other failings, frequently found in theſe ſtones, reduce the price by one third, and ſometimes more.

As to *brilliant diamonds* of very ſmall cut, the price is always leſs by one third, than that of *diamonds* of a larger cut, though the weight is the ſame: the reaſon is, that the latter ſhew themſelves a great deal more, when ſet in their collets, than the former.

Lapidaries uſually diſtinguiſh three kinds of Rubies, the *raky*, *balaſs*, and *ſpinell*; ſome add a fourth kind, *viz.* the *rabeculle*. It is the different degree of colour which makes their different value and beauty. The *balaſs ruby* is of a crimſon colour with a caſt of purple: the *ſpinell ruby* is of a bright roſy red.

The *ruby* is formed in a ſtony ſubſtance, or marcaſite of a roſe colour, called *mother of ruby*; it has not all its colour and luſtre at once; but comes to it by degrees. At firſt it grows whitiſh, and as it approaches to maturity, becomes red. Hence we have white *rubies*, others half white, half red, and others blue and red, called *ſaphire rubies*.

When a *ruby* exceeds 20 carats, it may be called a *carbuncle*, the name of an imaginary ſtone.

They have ſeveral manners of counterfeiting *rubies*; and have carried this imitation to that length, that the moſt able *Lapidaries* are ſometimes over-ſeen.

The value of *rubies*, from one carat, or four grains, to ten carats, is thus given us in the *Dictionaire de Commerce*, from a good hand,

	l.	*s.*	*d.*
A *ruby* of one carat, is worth	1	15	0
—— of two carats, — —	9	00	0
—— of three carats, ——	22	10	0
—— of four carats, — —	33	15	0
—— of five carats, — ——	45	00	0
—— of ſix carats, —— —	67	10	0
—— of ſeven carats, — ——	84	00	0
—— of eight carats, ——	106	00	0
—— of nine carats, — —	150	00	0
—— of ten carats, ——	216	00	0

The Saphire is tranſparent, yet exceedingly hard, ſo as ſcarce to bear being engraven.

Different colours bear different kinds thereof; the deepeſt blues being eſteemed males, and the whiteſt females. The *ſaphires* of *Pegu* are the moſt eſteemed.

The ſoft *water-ſaphires* of *Bohemia* and *Sileſia*, are of ſome account, tho' far inferior to the oriental ones, both in the brightneſs of their blue, and the firmneſs of their texture.

The Topaz is transparent, its colour a beautiful yellow, or gold colour: it is very hard, and takes a fine polish. It is the true chrysolite of the antients, and is found in several parts of the *Indies*, in *Ethiopia*, *Arabia*, *Peru*, and *Bohemia*.

The oriental *topazes* are most esteemed; their colour borders on the orange.

The *topaz* is easily counterfeited; and there are fictitious ones, which to the eye do not come behind the natural ones.

The Emerald is a very green and transparent stone, and as to hardness, next to the ruby.

The *oriental emerald* is harder, more brilliant, and transparent than the *Peruvian*; which has generally clouds found in it, and sparkles less.

The *emerald* is supposed to grow more and more perfect in the mine like the ruby; and to arrive at its greenness by slow degrees, as the fruit comes to maturity by degrees. It is a common opinion that the *emerald* grows in the jasper; and it is certain there are some jaspers so perfectly green, that many have taken them for *emeraldis*.

But the proper matrix, or marcasite of this stone, is the *prime*, which is held among the coarser precious stones; being hard, transparent, half opake, and usually intermix'd with yellow, green, white, blue, *&c.*

The first and coarsest sort of rough *emeralds*, called *plasmes*, for grinding, are worth 27 shillings sterling, the *mark*, or 8 ounces. The demi-morillons, 8 *l.* sterling, *per* mark. Good morillons, which are only little pieces, but of fine colour, from 13 *l.* to 15 *l. per* mark. *Emeralds*, larger then morillons, and called *of the third colour*, or *sort*, are valued at from 50 *l.* to 60 *l. per* mark. *Emeralds*, called *of the second sort*, which are in larger and finer pieces than the preceding, are worth, from 65 *l.* to 75 *l. per* mark.—Lastly, those of the first colour, otherwise called *negres cartes*, are worth from 110 *l.* to 115 *l.*

Emeralds ready cut, or polished and not cut, being of good stone, and a fine colour, are worth,

	l.	*s.*	*d.*
Those weighing one carat, or four grains,	0	10	0
—— of two carats,	1	7	0
—— of three carats,	2	5	0
—— of four carats,	3	10	0
—— of five carats,	4	10	0
—— of six carats,	7	10	0
—— of seven carats,	15	00	0
—— of eight carats,	19	00	0
—— of nine carts,	23	00	0
—— of ten carats,	33	00	0

Hyacinth is thus called from its resemblance of the purple flower, named *hyacinth*, or the violet.

There are four sorts of *hyacinths*; those intermixed with a vermillion colour; those of a saffron colour; those of an amber colour; and lastly those of a white, intermixed with a slight red.

Hyacinths, again, are distinguished into *oriental* and *occidental*.

The stone graves or cuts fine, and would be more used for seals, *&c.* but that the graving frequently costs more than the stone.

Amethyst is a precious stone of a violet colour, bordering on purple.

There are divers sorts of *amethysts*; the *oriental* which is the hardest, the scarcest, and most valuable, is of a dove colour; the *German* which is of a violet colour; and the *Spanish* which has the colour of a pansy.

There are some *oriental*, also, of a purple colour, and others white, and like the *diamond*.

The *amethyst* is not extremely hard, but may be cut with a leaden wheel, smeared with emery moistened in water. It is polished on a pewter wheel with tripoli; it is easily engraven on, either in creux or relievo.

The Beryl is a transparent stone or gem, brought from *India* of a light or pale green colour, insomuch that some have represented it as of two colours, the one green, the other pale.

The *beril* differs from the *chrysoberil*, which is somewhat paler, and partakes more of the yellow, and from the *chrysoprasus*, which partakes more of the green.

Some authors take the *beryl* for the diamond of the antients; this is certain, the ablest modern jewellers have sometimes mistaken the one for the other.

The Cornelian is a precious stone ordinarily red, bordering on orange, called also *sardius*, or the *sardian stone*. It is but little transparent, cuts easily; and we find most of the fine gravings of antiquity, whether in relievo, or indented, are on this stone. It bears the fire admirably.

The finest *cornelians* are those brought from near *Babylon*, the next are those of *Sardinia*, the last those of the *Rhine*, *Bohemia*, and *Silesia*. To give these stones the greater lustre, in setting them they lay a piece of silver leaf underneath.

The principal use made of *cornelians* is in seals, by reason they grave well, and take a fine polish.

Granate, popularly called *Garnate*, is a precious stone of a high red colour, thus called from the

the resemblance it bears of the kernel of a pomegranate.

Granates are either *oriental* or *occidental*; the first are brought from divers parts of the *East Indies*, the second from *Spain*, *Silesia*, and *Bohemia*.

Those from the *East* are distinguished by their colour into three kinds; the first of a deep brownish red, like black clotted blood; of which kind there are some as big as an hen's egg. The second are nearly of the colour of a hyacinth, with which it were easy to confound them, but for their superior redness. The last, having a mixture of a violet with their red, are called by the *Italians*, *rubini della rocha*.

The *occidental granates* are of divers reds, according to the places they are found in. Those of *Spain* imitate the colour of the kernels of a pomegranate: those of *Bohemia* have a golden cast with their red glittering like a live coal: those of *Silesia* are the darkest of all, and seldom thoroughly transparent.

Of the *occidental granates* those of *Bohemia* are the most valued: some even give them the preference to the oriental kind. They are found near *Prague*; not in any particular mines, but are picked up by the peasants in the fields from among the sands and pebbles.

The AGATE is a precious stone, partly transparent, and partly opake, usually diversified with a variety of colours, veins, spots, *&c.* sometimes exhibiting figures, or appearances of natural objects.

There are various kinds of *agates*; which according to their different colours, degrees of transparency, *&c.* have different names. The principal may be reduced to these four, *viz.* the *onyx*, *calcedony*, the *black*, and the *German* agates.

The *agate* has ordinarily a reddish teint, but is finely variegated with spots, and stains, many of which seem very naturally to represent woods, rivers, trees, animals, fruits, flowers, *&c.*

The *sardians*, and *sardonyx agates* are very valuable; the latter is of a sanguine colour, and is divided into zones, which seem to have been painted by art.

Agates have always been esteemed for seals, as being a stone that no wax will stick to.

The ONYX is a kind of precious stone, accounted a species of opake *agate*. It is of a dark horny colour, in which is a plate of a bluish white, and sometimes of red; the several colours appearing as distinct as if laid on by art.

White zones or girdles, are essential to an *onyx*.

The SARDONYX is a kind of precious stone partaking partly of the *sardian*, and partly of the *onyx*.

It is semi-transparent, and reddish bordering on white, somewhat like the nail of the hand: in some the red inclines to a yellow.

The TURCOIS, or TURQUOIS, is a precious stone of a blue colour, ordinarily opake, but sometimes a little transparent.

There are *turcoises* both oriental and occidental, of the new rock and the old. The oriental partakes more of the blue tincture than the green, and the occidental more of the green than the blue. Those of the old rock are a deep blue, and those of the new rock more whitish, and do not keep their colour.

The oriental ones come from *Persia*, the *Indies*, and some parts of *Turky*; and some even suppose that it is hence they derive their modern name *turcois*. The occidental are found in various parts of *Europe*, particularly *Germany*, *Bohemia*, *Silesia*, *Spain*, and *France*.

Turcoises all grow of a round or oval figure.

The *turcois* is easily counterfeited, and that so perfectly that it is impossible to discover the deceit, without taking it out of the collet.

The great defect of all *turcoises* is, that in time they lose their blue colour, and become green, and then cease to be of any value.

The OPAL is a precious stone of various colours, changeable according to the different position of the stone to the light.

In it are seen the red of the ruby, the purple of the amethyst, the green of the emerald; besides yellow, blue, and sometimes black and white. When the stone is broke, most of these colours disappear; which shews that they arise by reflection from one or two principal ones.

Its form is always either round, or oval; its prevailing colour white. Its diversity of colours makes it almost of equal value with a saphire or ruby.

L A W.

THE etymology of *law* is either from *legendo*, reading; or from *eligendo*, chuſing; or from *ligando*, tying, obligating. — It may be deduced from *legendo*, reading; for though it is not eſſential to the *law* that it ſhould be written, according to *Juſtinian*'s inſtitutions, *c.* 25. *q.* 2. and to *Ariſtotle*, *lib.* 10. *Eth. c.* 9. where he expreſſes himſelf in theſe words; *whether the laws be written, or not written, it does not ſeem to matter much*: the *law*, notwithſtanding, is moſt commonly written, that every body may read in it what he is to do, or to avoid. — It may alſo be derived from *eligendo*, chuſing; becauſe *law* is like a certain choſen rule, or form of living. This etymology is that of *Tully*, *lib. de leg.* Laſtly, it may be derived from *ligando*, tying or obliging; becauſe it obliges the ſubjects to its obſervance.

All *law* is either *natural*, or *poſitive* — The *natural law* is conſidered either in God or in us. In God it is called *eternal law* or *eternal order*. In us it is either called *right reaſon* or *natural light*; or retains ſimply the name of *natural law* or *order*.

The *poſitive law*, is that eſtabliſhed by the free-will of a legiſlator; and ſubject to alterations or changes thereof, are called by different names by the *Roman* Juriſconſultes. For among them the law is defined, *lex rogatur*, when it is made, becauſe there was no law made unleſs aſked by the people. It is *abrogated*, *abrogatur*, when entirely aboliſhed; *derogated*, *derogatur*, when part thereof was taken off: *ſubrogated*, *ſubrogatur*, when additions were made thereunto; and *abrogated*, *abrogatur*, when ſome changes were made in it.

The *poſitive law* is either divine or human; the firſt is from God, and the latter from men.

The *divine law* is contained in the Old and New Teſtament; whence it is either antient or new.

The *old* or *antient law*, is that given to the *Hebrews*, by the miniſtry of *Moſes*, or as the Apoſtle expreſſes himſelf, *Gal.* iii. 19. *It was ordained by Angels in the hand of a Mediator.*

The *new law* is called the *law of the Goſpel*, or of the New Teſtament, is that brought to all men by Chriſt, author of the *New Teſtament*.

The *human law*, is that made and eſtabliſhed by men; and this is either *eccleſiaſtical* or *civil*.

The *eccleſiaſtical law*, conſiſts in the canons of the general councils, the ſentiments of the fathers, and the conſtitution of the Popes, called decretal, amongſt thoſe in communion with the church of *Rome*; and in ſuch antient conſtitutions and privileges as the clergy are entitled to in *England*, by the laws of the land.

The *civil law* conſiſts in the conſtitutions of a republick, or in the edicts of emperors, and kings, in the deciſions of a ſenate, or of the canons, in the anſwers of prudent men, and in a long cuſtom, approved by the unanimous conſent of the people. This ſeems to be the general diviſion of all *laws*.

As to the matter ſubject to *law*, it is the *right itſelf*, or what is juſt, or what is acted or omitted juſtly.

Thus much concerning *law* in general, of the different diviſions and ſubdiviſions thereof, are as follow.

Every body agrees, that the *eternal law* is the ſource of all others, and the firſt rule of all our actions. For the *eternal law*, ſays St. *Auguſtin*, *lib.* 22. *cont. Fauſt. c.* 27. *is the divine reaſon, or God's will commanding to preſerve the natural order, and forbidding to diſturb it.* Natural order, in this place, *is that*, ſays he himſelf, *lib.* 2. *de ordin. c.* 10. *whereby all things are done, which God has eſtabliſhed.* Therefore the *eternal law* is an immutable reaſon, to which all that is done rightly and juſtly is agreeable, and all that is done wrong diſagreeable.

Natural law alſo called *right reaſon*, *natural light*, and *natural order*, is the *eternal law* itſelf, or a certain participation of the *eternal law*, in a rational being, whereby he is made capable to diſtinguiſh between good and evil.

Lawyers call *natural law*, that, which nature has taught all kinds of animals without diſtinction, ſuch as their *conſervation*, *procreation*, the *education* of children, *&c.* But the Divines call *natural law*, that which God has imprinted on man's mind.

That this *natural law* is imprinted in our minds, is evident from that every body underſtands what is good, and what is bad.

We'll paſs to the *law of nations*, and aſk firſt, *what is the law of nations, and whether it pertains to the natural law?*

I anſwer, 1. That *the law of nations is that which natural reaſon has eſtabliſhed among men, and which is obſerved almoſt by all men.*

1. It is called *law*, becauſe it has the property of a *law*, which is that it ſhould be entirely juſt.

2. *Which the natural reaſon or light has eſtabliſhed among men*, becauſe through the exigency of their affairs,

affairs, men of almoſt all nations have eſtabliſhed it.

3. *And which is obſerved by almoſt all men*; becauſe almoſt all nations obſerve that *law* to which they have almoſt all given a ſanction.

If I be aſked, which are thoſe precepts which have been made, and are kept by almoſt all nations? I'll anſwer, that the principal of them are *manumiſſions*, *war*, the difference *made between nations*, *the condition of kingdoms*, *the difference of government*, *the partitions of lands*, *buildings*, *commerce*, *emptions*, *venditions*, *locations*, *conductions*, &c.

I anſwer, 2. *That the law of nations pertains rather to the poſitive than to the natural law*; becauſe eſtabliſhed and calculated by men for the ſecurity of the civil ſociety; for it differs from the natural law, in that the inſtitution of the natural law does not depend of men, and is not ſaid to be in force among almoſt all men, but among all without reſtriction.

Divine law is that rule given by GOD to his people, the *Hebrews*, for their guide in his worſhip, and their lives, conduct, and government which was from time to time revealed to the world by *Moſes*, and the prophets, from the beginning of the world, till it was fully completed by a *new Revelation*, delivered to us by JESUS CHRIST the *Sun of Righteouſneſs*. See *Hebrews* i.

The *old law* conſiſted of *moral*, *judicial*, and *ceremonial* precepts, ſtatutes and conſtitutions, which are chiefly contained in the books of *Exodus* and *Leviticus*. The *ceremonial*, otherwiſe called the *levitical law*, was abrogated by the *new law* delivered by CHRIST.

With regard to this new law we'll aſk, *what it is, and how many precepts it has?*

I anſwer, 1. That the *new law*, or the *law of the Goſpel*, is defined *a divine poſitive law, given to all men by their legiſlator Chriſt.*

It is called *law*, becauſe the definition of law is proper to it.

It is called *poſitive*, to diſtinguiſh it from the eternal and natural law.

It is ſaid *given to all men*, to diſtinguiſh it from the old law given only to *Abraham* and his poſterity.

It is ſaid by *Chriſt*, becauſe Chriſt himſelf calls his precepts in ſeveral places of the ſcripture, the precepts of the new law.

I anſwer, 2. *That there are three ſorts of precepts of the new law*, viz. *moral precepts*, *the precepts of faith*, *and the precepts of the ſacraments*; which can be proved by the ſcripture. For *Matt.* v. vi. Chriſt explains the moral precepts of the decalogue. And *Matt.* ix. forbids divorce, and the libel of repudiation, and decrees that the conjugal knot ſhould be indiſſoluble.

As to the *precepts of the ſacraments*, it is ſaid, *John* iii. *Except a man be born of water and of the ſpirit, he cannot enter into the kingdom of God.* And *John* vi. *Except you eat the fleſh of the ſon of man, and drink his blood, you have no life in you.*

As to the *precept of faith*, it is ſaid *Mark* xvi. *But he that believes not ſhall be damned.*

There is this difference between theſe three kinds of precepts; that the *moral* ones being of the natural law, were not inſtituted by CHRIST, but only explained, and vindicated from the errors they had been involved in by men's malice. But that the *ſacramental* were inſtituted by Chriſt, to ſupply the place of the old ones abrogated by him. That the precepts of *faith* were not inſtituted anew, but only, from implicit, were made more clear; ſo that we are obliged at preſent to believe ſome precepts explicitly, which, in the old law they believed only implicitly; ſuch as the *Nativity*, *Paſſion*, and *Death* of *Chriſt*, and all the other myſteries, which are only believed obſcurely by the *Jews*, and are at preſent believed expreſly by the *Chriſtians*.

The *human law*, next to the *divine*, falls under our conſideration.

Men's minds being agitated by various affections, and darkned by errors, deviate from the right way of reaſon and ſimplicity. Extravagantly infatuated with their own pretended merit, they behave themſelves towards others with haughtineſs, and injuſtice, envying their fortune, jealous of their merit, and great and noble actions, rejoicing at their adverſities, perfidious, calumniators, plunderers, falſe, always ready to offend them, and almoſt never to do them good: therefore *human laws* were neceſſary, which eſtabliſhing puniſhments ſhould maintain the natural and divine law, correct the delinquents, keep rebels in awe, and contain all in their duties; for if there was no fear of puniſhment, the moſt ſacred and wholeſome laws would be neglected by the indolent, infringed by the wicked, and deſpiſed by the audacious.

Therefore the human laws are eſtabliſhed to give a greater authority to the *natural law*, that no-body ſhould either omit it, or violate unpuniſhed.

HUMAN LAWS are divided into *eccleſiaſtical* and the *civil*.

The *eccleſiaſtical law* is that eſtabliſhed by, or for the uſe of the church, or religious conſtitution in every nation. This is alſo commonly called the *canon law*. The power of making *laws* has been granted to the church.

In the firſt council, viz. that of *Jeruſalem*, *Acts* xv. a law was made, that the Gentiles converted to the chriſtian faith, ſhould abſtain from blood, and

and from ſuffocated. St. *Paul*, 1 *Tim.* iii. 2. forbids that the *Bigames* ſhould be promoted to *epiſcopacy*, and by their example ſeveral things have been eſtabliſhed in the church, by the canons of the Apoſtles, general councils, and by the conſtitutions of different churches; and theſe laws have been collected and digeſted by authors, in ſeveral nations and languages: as the *Decretum Gratiani*, the *Gregorian Collection*, by *Pope Gregory* IX. The *Clementines*, the *Extravagantes*, the *Concordati*, &c.

In *England*, ſince the reformation, the *canon law* has been much abridged and reſtrained; only ſo much of it obtaining, as is conſiſtent with the common and ſtatute laws of the realm, and the doctrine of the eſtabliſhed church.

The CIVIL LAW is that made by either a prince or a republick, and which all the ſubjects of that prince or republick are obliged to obey.

They who command others, have a right to call to an account thoſe, who deſpiſe their laws; which is confirmed by the Apoſtle, *Rom.* xiii. 1. *Let every one be obedient to the ſuperior power; for there is no power but from God:* therefore he who reſiſts power, reſiſts God's ordinance.

From which expreſſions it is eaſy to underſtand, that the *civil law* is political, and temporal with regard to the object and the things commanded; but that the obligation ariſing from it, is internal and ſpiritual; and that the obſervance thereof cannot be deſpiſed with a ſafe conſcience.

Firſt, God himſelf dictated civil precepts to the *Jews*. The moſt antient people, and particularly the *Greeks*, digeſted and reduced into writings their civil laws, ſuch were thoſe of *Solon*, *Lycurgus*, and others, which all flow from the natural law; and perhaps are taken in part from the law of *Moſes*. But the *Romans* have excelled in that all other nations.

Beſides the laws of *Romulus*, and of the other kings, which were in force while the royal authority laſted; they took care, after the expulſion of the king, to make laws agreeable to the republican government they had eſtabliſhed among them, to keep the citizens under a juſt and reaſonable ſubjection, to compoſe their differences, *&c.* To that effect, they ſent about the year 300 of the foundation of *Rome*, three deputies to *Athens*, and to the other cities of *Greece*, to collect the laws of thoſe people, and bring them to *Rome*. Theſe being return'd three years afterwards, ſeven other men, eminent for their extraordinary merit, were joined to them, to make a choice of thoſe laws, and who digeſted them into *ten tables*, to which ſoon after, by reaſon that ſome of thoſe laws were defective, were added two more tables: ſo that thoſe *twelve tables* became afterwards the ſource of all the private and publick laws. Thoſe compilers were called *decemviri*; whence the laws of the *twelve tables* we alſo called *decemviral laws*.

Next to theſe *tables*, amongſt thoſe properly called *laws*, were the *plebiſcita*, made by the *Plebeians*; the *ſenatuſconſulta*, by the ſenate; the *edicts* of the pretors, whence proceeded a right called the *honorary right*: and theſe *edicts* having been collected into one body, that body was called the *perpetual edict*.

The face of the republick being changed, and the empire deferred to one perſon only; there enſued ſeveral conſtitutions of the emperors, which during very near 500 years, *i. e.* from *Auguſtus* to *Juſtinian*, increaſed in a ſurprizing manner.

Of theſe conſtitutions of the emperors, from *Adrian* to *Conſtantine*, were compoſed two codex's, in the time of *Dioclefian*, one by *Gregory*, and the other by *Hermogenes*, both private perſons. The emperor *Theodoſius* the younger, gave the third codex, digeſted by eight prudent perſons, in which he included the conſtitutions of the emperors, from *Conſtantine* to himſelf.

At laſt the emperor *Juſtinian* perfected quite the *Roman* juriſprudence. For in the year of Chriſt 528, he appointed ſome illuſtrious perſons to free the *Gregorian*, *Hermogenian*, and *Theodoſian* codex's of their too tedious prolixity, and to compoſe of them another under the name of *Juſtinian*. Agreeable to the emperor's expectations they perfected the *Juſtinian* codex, which he approved and confirmed by an imperial conſtitution, given in the year 529.

Afterwards, he cauſed to be compriſed into a ſingle work, all the antient laws divided into fifty books, which work was called the *digeſt*, or *pandects*.

Then he publiſhed an epitome of the *civil law*, diſtributed into four books, for the uſe of young ſtudents in the law, and which he called, *The Epitome of the Inſtitutions of the Civil Law*.

But as he found that ſeveral things were omitted in the codex, or not treated with that accuracy he deſir'd, he cauſed it to be corrected in ſeveral places, and would afterwards give a ſecond edition thereof more correct than the firſt, and this is, *Repetitæ prælectionis codex*; which we read in the body of the civil law.

The *novellæ* were ſoon added to it, or 168 new conſtitutions. So that the whole body of the civil law conſiſts of four collections, *viz.* the four books of *inſtitutions*, fifty books of *digeſts* or *pandects*, twelve books of the *codex*, and 186 novels. From which novels were extracted ſhort ſentences, which in the diviſion of the *codex*, were inſerted in ſeveral places thereof, and are called *Authenticæ*, becauſe confirmed by the authority of the emperor.

But

But as the fifty books of *digeſts* or *pandects*, with the *gloſſa*, could not be contained in one volume, bookſellers have divided them into three, calling the firſt volume the *antient Digeſt*; becauſe it was publiſhed firſt, the ſecond *Infortiate*, becauſe it gives a clearer, and more ample knowledge of the law; and the third the *new digeſt*, becauſe publiſhed laſt.

Each book of the *pandex* and *codex* is divided into titles, and the titles into laws, and the laws into paragraphs. Therefore, when ſome law of the *digeſts* or *pandects* is quoted, the name of the digeſt is ſignified by the majuſcule letter D. And of the *pandects*, by a *Greek* π with a circumflex, in place whereof the printers ſubſtitute a double *ff*. For example, if any body wants to quote the third paragraph of the firſt law of the firſt title of the *digeſts* or *pandects*, which has for title *de Juſtitiâ & Jure*, he'll ſay, the *natural right is what nature has taught all animals*, from *lib* 1. *paragra.* 3. *D.* or *ff. de Juſtitiâ & Jure*, i. e. the firſt law, third paragraph of the *digeſt* or *pandect*, title *de Juſtitiâ & Jure*.

And in the codex, *L. nemo* 2. *cod. de Sacroſanct. Ec.* i. e. the law which begins at this word *nemo*, which is the ſecond law in the codex, title *de Sacroſanctis eccleſiis*. This title is the ſecond of the firſt book. If the *Authentica* is quoted, it muſt be ſaid, *Authen. caſſa, cod. de Sacroſanctis Eccleſiis*, &c. The *novels* are quoted by their proper names, and the chapters thereof are indicated. The inſtitutions of the civil law are commonly quoted by paragraphs and titles.

The *Roman* civil law thus compoſed with ſo much art and care, is of great authority in almoſt all *Europe*; where it is ſimply called *law*.

For though there be ſcarce any kingdom or province in *Europe* which has not its particular uſe and cuſtoms; in them notwithſtanding the *written law*, i. e. the *Roman law* is a rule whenever the cuſtomary, or common law is deficient. Which is rightly obſerved by *Obertus de Orto*, a lawyer, of *Milan*, *lib.* 2. *de Feudis. Tit.* 1. in theſe words, *An experienced lawyer, if a caſe ariſes, which is not contained in the common law, can very well have recourſe to the written law.*

The *law of England* conſiſts of three parts: 1. The *common law*, which is the moſt antient and *general law* of the realm. 2. *Statutes*, or acts of parliament. 3. *Particular cuſtoms*.

The *common law of England* is derived from the *Engliſh*, *Saxons*, and *Danes*, and was antiently divided into three parts, *viz.* the *Mercian law*, the *Weſt-Saxon law*, and the *Daniſh law*.

Thoſe called *Mercian laws*, are commonly ſaid to have been compoſed by *Martia*, queen of the *Britons*, from whom there was a province called *Provincia Merciorum*. Many laws were alſo publiſhed by *Ethelred*, king of *Kent*, by king *Ina*, and *Offa*; but *Alfred*, who ſubdued the whole kingdom, having reviſed all the laws of his predeceſſors, retained thoſe which he thought proper, and aboliſhed the reſt; whence he is called *Anglicarum Legum Conditor*; and theſe laws were called *Weſt-Saxene-laga*.

But the kingdom being afterwards ſubdued by the *Danes*, they introduced another law, called *Dane-laga*, by which their people were governed; and they being afterwards deſtroyed, *Edward the Confeſſor*, out of the former laws, compoſed that, now called the *common law*; for which reaſon he is called by *Engliſh* hiſtorians, *Anglicarum Legum Reſtitutor*.

Theſe laws were only general cuſtoms, obſerved thro' the nation, and for that reaſon, were called *common*; and perhaps alſo, *Leges omnibus in commune reddidit*: to be obſerved by all, with ſuch amendments as were afterwards to be made.

William the Conqueror did not exact many new laws, but confirmed the old, *viz.* St. *Edward's* laws; and abrogated none that any ways concern'd compoſitions, or mulcts of delinquents: but unfortunately brought along with him from *Normandy*, the litigious ſpirit of that nation; which has been ſince cultivated, and much improved in this land, to the oppreſſion of its inhabitants.

The *common law* is alſo called *lex non ſcripta* (not but moſt of them are wrote in the old *Norman* dialect) but becauſe it cannot be made by charter, or parliament; for thoſe are always matters of record, whereas *cuſtoms* are only matters of fact, and are no where but in the memory of the people, and of all laws, are the beſt for the *Engliſh*; for the written laws, made by king and parliament, are impoſed upon the ſubjects before any probation or trial, whether they are beneficial to the nation, or agreeable to the nature of the people, except where they are firſt made temporary, and for their experienced uſefulneſs afterwards, made perpetual; but cuſtoms bind not till they have been try'd and approved time out of mind.

Beſides the *common law of England*, in general, there are in ſeveral parts of it, certain cuſtoms and common uſages, which have the force of *common law* among thoſe people, to whoſe property they belong; as *Borough Engliſh*, a cuſtom ſo called, as not being in uſe out of *England*, where the youngeſt ſon, or for want of ſons, the youngeſt brother is to inherit; the eldeſt being ſuppoſed to have learned the father's trade, and the youngeſt the leaſt able to ſhift for himſelf.

Where the *common law* is ſilent, there are *ſtatute laws*, made by the ſeveral kings of *England*, with

with the advice and conſent of both houſes of parliament.

For the adminiſtration of theſe laws, there are ſeveral courts of judicature, *viz.* the *chancery*, *exchequer*, *king's bench*, and the court of *common pleas*.

The CHANCERY is the grand court of equity and conſcience, inſtituted to moderate the rigour of the other courts, that are tied to the ſtrict letter of the law; for as far as I can underſtand, and know by experience, law is not always founded on juſtice, equity, and conſcience; and what's law, is often very unjuſt.

The judge of this court is the lord high-chancellor, who is the firſt perſon of the realm, next after the king and princes of the blood, in all civil affairs. He is the chief adminiſtrator of juſtice next the ſovereign.

All other juſtices are tied to the ſtrict law, but the chancellor has an abſolute power to moderate the rigour of the written law, to govern his judgment by the law of nature and conſcience, and to order all things *ſecundum æquum & bonum*. Accordingly, *Stamford* ſays, the chancellor has two powers, the one abſolute, the other ordinary; meaning, that though by his ordinary power he muſt obſerve the ſame form of procedure as other judges; yet in his abſolute power he is not limited by any written law, but by conſcience and equity.

The offices of *lord-chancellor* and *lord-keeper*, are by the ſtatute 5 *Eliz.* make the ſame thing; till that time they were different, and frequently ſubſiſted at the ſame time in different perſons.

The *keeper* was created *per traditionem magni ſigilli*; but the lord-chancellor by patent; though now that he has the keeper's office, he is created in like manner by giving him the ſeal. The chancellor is likewiſe ſpeaker of the houſe of lords.

Though the lord-chancellor be the ſole judge of the court of *chancery*, yet in matters of much difficulty he ſometimes conſults the other judges; ſo that this office may be diſcharged by one who is not a profeſſed lawyer, as antiently it commonly was. He has twelve aſſiſtants, or coadjutors, antiently called *clerici*, as being in holy orders, now maſters in *chancery*, the firſt whereof is the maſter of the rolls.

The maſter of the rolls, is a patent officer for life; who has the cuſtody of the rolls and patents, which paſs the great ſeal, and of the records of the chancery.

In the abſence of the lord-chancellor or keeper, he alſo ſits as judge in the court of *chancery*, and is called by Sir *Edward Coke*, his aſſiſtant.

At other times he hears cauſes in the Rolls-chapel, and makes orders and decrees. He likewiſe has the aſſiſtance of the other maſters in *chancery*; but all hearings before him are appealable to the lord-chancellor.

He has alſo his writ of ſummons to parliament, and ſits next to the lord chief-juſtice of *England*, on the ſecond woolpack. He has the keeping of the parliament's rolls, and the rolls houſe for his habitation; has alſo the cuſtody of all charters, patents, commiſſions, deeds, recognizances, which being made of rolls of parchment, gave riſe to the name. Antiently he was called *clerk of the rolls*.

In his gift are the ſix clerks in *chancery*, the examiners, three clerks of the petty-bag, and the ſix clerks of the rolls chapel, where the rolls are kept.

The maſters of *chancery* are uſually choſen out of the barriſters of the common law, and ſit in *chancery*, or at the rolls, as aſſiſtants to the lord chancellor, and maſter of the rolls.

To them is alſo committed interlocutory reports, ſtating of accompts, taxing coſts, *&c.* and ſometimes by way of reference, they are empower'd to make a final determination of cauſes.

They have, time out of mind, had the honour to ſit in the houſe of lords, though they have neither writs nor patents to empower them, but as aſſiſtants to the lord chancellor, and maſter of the rolls. They had antiently the care of inſpecting all writs of ſummons, which is now perform'd by the clerk of the petty-bag. When any meſſage is ſent from the lords to the commons, it is carried by the maſters of *chancery*. Before them affidavits are made, and deeds and recognizances acknowledged.

Beſides theſe, who may be called *maſters of chancery ordinary* (being twelve in number, whereof the maſter of the rolls is reputed the chief) there are alſo *maſters of chancery extraordinary*, appointed to act in the ſeveral counties of *England*, beyond ten miles diſtance from *London*, by taking affidavits, recognizances, *&c.* for the eaſe of the ſuitors of the court.

For the equity part of the court of *chancery* are ſix clerks, who have each under him about fifteen more, in the nature of attorneys of the court; two chief examiners, for examining witneſſes, who have each five or ſix clerks apiece, one principal regiſter, who has four or five deputies; clerk of the crown, who makes out writs, commiſſions, *&c.* warden of the fleet, ſerjeant at arms, who bears the mace before the chancellor, and the uſher and crier of the court.

The *ſix clerks* are officers of great account, next in degree below the twelve maſters, whoſe buſineſs is to enroll commiſſions, pardons, patents, warrants, *&c.* which paſs the great ſeal. They are

attornies

attornies for parties in ſuits depending in the court of chancery.

Under them were formerly ſixty clerks, who with the under-clerks did the buſineſs of the office; which number was afterwards increaſed to ninety. At preſent the number is indefinite; an order having been made, for reducing them to their antient number of ſixty; by not filling up the vacancies that may happen by death, &c. till they are fallen to that ſtandard.

The *examiners* are two officers, whoſe buſineſs is to examine on oath, the witneſſes produced on both ſides, upon ſuch interrogatories, as the parties to the ſuit do exhibit for the purpoſe.

The *clerk of the crown*, is an officer, who by himſelf, or deputy, is continually to attend the lord-chancellor or lord-keeper, for ſpecial matters of ſtate, by commiſſion, or the like, either immediately from his majeſty, or by order of his council, as well ordinary as extraordinary. All general pardons, upon grant of them at the king's coronation, or in parliament; the writs of parliament, with the names of the knights, citizens, and burgeſſes, are alſo returned into his office; beſides which he has the making of ſpecial pardons, and writs of executions upon bonds of ſtatute-ſtaple forfeited.

To the common law part, in *chancery*, belongs the twenty-four curſitors, and their clerks, who make out original writs; clerks of the petty-bag; clerks of the hanaper; comptroller of the hanaper; clerk of appeals; clerk of the faculties; ſealer; chaſe-wax; clerks of the patents, of preſentations, diſmiſſions, licenſes to alienate, enrollments, protections, ſubpæna's, affidavits, &c.

The *curſitors*, alſo called *clerks of the courſe*, are twenty-four in number; making a corporation of themſelves. To each of them are alloted ſeveral ſhires; in which ſhires they make out ſuch original writs, as are by the ſubject required.

Clerk of the hanaper, is an officer, whoſe buſineſs is to receive all money due to the king for the ſeals of charters, patents, commiſſions, and writs: as alſo fees due to the officers for enrolling and examining the ſame. He is obliged to attend on the lord-chancellor, or lord-keeper, daily in term-time, and at all times of ſealing.

Comptroller of the hanaper, is an officer attending the lord-chancellor daily in term and ſeal-time. He is to take all things ſealed from the clerk of the hanaper, incloſed in bags of leather, and to note the juſt number and effect thereof; to enter them in a book, with all the duties belonging to the king and other officers for the ſame, and ſo charge the clerk of the hanaper with them.

The *court of* EXCHEQUER is a court wherein are tried all cauſes relating to the king's treaſury or revenue; as touching accounts, diſburſements, cuſtoms, fines, &c.

It conſiſts of ſeven judges, *viz.* the lord-treaſurer, the chancellor of the *exchequer*, the lord chief baron, and three other barons of the *exchequer*, with one curſitor baron.

The *chancellor of the exchequer* is an officer ſuppoſed by ſome to have been created for qualifying extremities in the *exchequer*. He ſometimes ſets in that court and the exchequer-chamber, and with the reſt of the court orders things to the king's beſt benefit. He is always in commiſſion with the lord-treaſurer, for letting lands accruing to the crown by diſſolution of abbies, and otherwiſe: he has power with others to compound for forfeitures on penal ſtatutes, bonds, and recognizances entered into by the king. He has a great authority in managing the royal revenue, and in matters of firſt-fruits.

The barons of the *exchequer* are judges, to whom the adminiſtration of juſtice is committed in cauſes between the king and his ſubjects, touching matters belonging to the *exchequer*, and the king's revenue.

They are called barons, becauſe barons of the realm were uſed to be employ'd in that office.

Their office is alſo to look to the accompts of the king; to which end they have auditors under them, as well as to decide cauſes relating to the revenue, brought by any means into the *exchequer*. So that of late they have been conſtantly perſons learned in the law; whereas formerly they were *majores & diſcretiores in regno, ſive de clero eſſent ſive de curiâ*. The lord chief baron is the principal judge of the court.

The court of *exchequer* is divided into two; the one of law, the other of equity.

All judicial proceedings, according to *law*, are ſtiled *coram baronibus* only; but the court of equity held in the exchequer-chamber, is *coram theſaurario, cancellario & baronibus*, before the treaſurer, chancellor, and barons.

For a long time after the conqueſt, there ſet in the *exchequer* both ſpiritual and temporal barons of the realm, but of latter times there have ſate in their places other judges, who, though no peers of the realm, yet retain the original denomination.

The common opinion of *Engliſh* hiſtorians is, that this court was erected by *William the Conqueror*, ſoon after his having obtained the kingdom: that the *Engliſh* exchequer was a court of the higheſt juriſdiction; that the acts thereof were not to be examined by any of the ordinary courts; that it was the repoſitory of the records of all the other courts, and that it was to be held in the king's court, and before him; and that it was concerned in the prerogative as well as the revenue of the crown.

The immediate profits of the crown, as of franchiſes, lands, tenements, hereditaments, debts, duties, accounts, goods, chattels, all diſburſements, ſeizures, and fines impoſed on the ſubjects, *&c.* are within the juriſdiction of the *exchequer*. And the king's attorney may exhibit bills for any matter concerning the king in inheritance or profits; ſo alſo may any perſon who finds himſelf aggrieved in any cauſe proſecuted againſt him, on behalf of the king, or any patent by grant of the king, exhibit his bill againſt the king's attorney, to be relieved by equity in this court.

To this court belong two officers, the king's *remembrancer* office, and that of the lord treaſurer's *remembrancer*; whoſe buſineſs is to put the lord treaſurer and juſtices of the court in remembrance of ſuch things as are to be called upon, and dealt in for the king's benefit.

There is a third *Remembrancer*, called *of the firſt-fruits*, who takes all compoſitions and bonds for firſt-fruits and tenths; and makes proceſs againſt ſuch as do not pay the ſame.

The two *Chamberlains* keep a controulment of the pells, of the precepts and exitus, and have certain keys of the treaſury and records; they alſo keep the keys of that treaſury, where the leagues of the king's predeceſſors and divers antient books, as *domeſday-book*, and the *black book* of the *Exchequer* remain.

Domeſday or *domeſ-day-book*, *liber judiciarius vel ſenſualis Angliæ*, the judicial book, or book of the ſurvey of *England*, is a moſt antient record made in the time of *William the conqueror*, upon a ſurvey or inquiſition of ſeveral counties, hundreds, tithings, *&c.* Its name is formed from the Saxon *Dom*, doom, judgment, ſentence, and *day*, which has the ſame force, ſo that *domeſday* is no more than a reduplicative, importing judgment.—The drift or deſign of the book is to ſerve as a Regiſter, by which ſentence may be given in the tenures of eſtates; and from which that noted queſtion, whether lands by antient demeſne or not, is ſtill decided; its contents are ſummed up in the following verſes:

Quid deberet fiſco, quæ quanta tributa,
Nomine quid cenſus, quæ vectigalia quantum
Quiſque tenetur feodali ſolvere jure,
Qui ſunt exempti, vel ques angaria damnat,
Qui ſunt vel glebæ ſervi, vel conditionis,
Quove manumiſſus patrono jure ligatur.

This book is ſtill remaining in the *Exchequer* fair and legible, conſiſting of two volumes, a greater and a leſs; the greater comprehending all the counties of *England*, except *Northumberland*, *Cumberland*, *Weſtmoreland*, *Durham*, and part of *Lancaſhire*, which were never ſurveyed: and except *Eſſex*, *Suffolk*, and *Norfolk*, which are comprehended in the leſſer volume, which concludes with theſe words: *Anno milleſſimo octogeſimo ſexto ab Incarnatione Domini, vigeſimo vero Regis Wilhelmi, facta eſt deſcriptio non ſolum per hos tres comitatus, ſed etiam alios.* It is called *Liber Judicialis*, by reaſon a juſt and accurate deſcription of the whole kingdom is contained therein; with the value of the ſeveral inheritances, *&c.* It was begun by five juſtices aſſigned for that purpoſe in each county, in the year 1081, and finiſhed in 1086. *Camden* calls it *Gulielmi librum Cenſualium*, King *William*'s tax-book.

King's Bench, is a court or judgment-ſeat, ſo called, in regard the king is ſuppoſed to ſit in perſon as judge of the court, and may do ſo whenever he pleaſes; for which reaſon, all writs and other proceſſes in this court, are made returnable *coram nobis*, i. e. before the king himſelf; and not *coram juſticiariis noſtris*, as in the form in the *common pleas*.

The judges of this court, are the Lord chief juſtice, and three other puiſne juſtices.

The chief juſtice is conſtituted by writ, and is to hold *quamdiu ſe bene geſſerit*. He preſides under his Majeſty in this court, but when the court divides, in giving judgment upon any ſpecial argument he hath but one voice; ſo that if the opinion of the court ſhould be equally divided, the matter muſt reſt till one of the judges ſhall ſee juſt reaſon to alter his opinion. He is to attend the Lords in Parliament, though he has no vote, unleſs he be a Peer himſelf, but is to give his opinion and advice to the houſe by virtue of a writ of aſſiſtance; and is frequently, therefore, conſulted by them, both in making and repealing laws, and in altering or explaining them. He makes a return of all writs of error in Parliament, directed to this court, and with his own hand delivers the writ of error, and a tranſcript of the proceedings in the cauſe into the houſe of Lords.

The three *puiſne* or *inferior judges* of this court, go the circuits, and are in commiſſion of *Oyer* and *Terminer* at the *Old Bailey*.

There are ſeveral officers belonging to this court, as two chief clerks or prothonotaries, who are ſuppoſed to enter all the pleadings and judgments between party and party; although this is done by an entring-clerk under them; and all writs of *Latitat*, *Non Omittas*, bills of *Middleſex*, *Habeas Corpus*, &c. are ſubſcribed with the names of theſe chief clerks.

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The ſecondary acts as maſter of the office on the pleas ſide, and is the chief clerk's deputy; his buſineſs is to examine any perſon, who is to be ſworn an entring clerk, or attorney at large, whether he be duly qualified, and to preſent him to the chief juſtice. He alſo ſigns all judgments, and gives coſts upon them; and the court upon any motion, in relation to the irregular practice of any clerk or attorney, generally refers the examination thereof to him. He alſo takes all affidavits in court (unleſs on the crown ſide) and the acknowledgment of all deeds in court.

The chief clerk, or prothonotary, has alſo a deputy, who keeps the ſtamp for ſigning all writs and proceſſes of this court; and with him are kept the remembrances of all records, whereby any record may be eaſily found, if the term wherein it was enter'd be known, *&c.* Likewiſe all common writs return'd, poſteas and writs of error, and common or ſpecial bails, after they are accepted, are filed in his office.

The office of the *Cuſtos Brevium* is to file all original and other writs, whereon you proceed to outlawry. He examines and ſeals all records of *niſi prius*, for trials at the aſſizes in ſeveral counties, and hath ſeveral clerks under him for making up records throughout *England*; but many times the plaintiff's attorney, *&c.* diſpatches this buſineſs, paying a fee of 6 *s.* 6 *d.* for every preſs of ſixty-ſix lines. This officer alſo files all warrants of attorney, is clerk of the eſſoins, and of the treaſury.

The two clerks of the papers receive all ſpecial pleas, demurs, and other pleadings, and make up the paper-books thereof; which the attorney for the plaintiff moſt commonly ſpeaks for, and afterwards gives a rule on the ſide of the book, for the defendant's attorney to bring them again, to be entered within four days, or judgment to go by default: they read in court affidavits, records, and proceedings.

The clerk of the declarations, is an officer of the court, who files all declarations after they are engroſſed in parchment, and continues them on the back from the term you declare, till iſſue is joined, *&c.*

The ſigner and ſealer of bills, keeps a book of entry of the names of the plaintiffs and defendants, in all bills of *Middleſex*, &c. and the defendants therein enter their appearance with him; in whoſe office ſearch may be made for any writ or appearance.

The clerk of the rules takes notes of all rules and orders made in court on the plea-ſide, and afterwards draws them up, and enters them in a book at large, for which he has 8 *d.* fee, and for the copy of each rule 4 *d.* if in term, and double out of term; and he, or the clerk of the papers, files all affidavits uſed in court, and makes copies of them at 4 *d. per* ſheet; alſo with him are given all rules of courſe, as on a *Capi Corpus*, *Habeas Corpus*, for procedendo's, poſtea's, writs of inquiry, *&c.*

The clerk of the bails and poſtea's, files the bail pieces, and marks the poſtea's, *&c.* and he, or his deputy, attends in the king's bench office for that purpoſe. With this officer you file all affidavits of ſervice, of proceſs for common bail, when the defendant does not appear.

The clerk of the errors allows all writs of error, and makes ſuperſedeas's, whereupon and into what county you pleaſe. He likewiſe makes tranſcripts of records, to be carried into the exchequer-chamber or the houſe of lords.

The clerk of the docquets enters the judgments, iſſues, and proceedings, and keeps docquets of them, ſo that with him you may find if any judgment be enter'd, *&c.* and he keeps a book for entering commitments and ſurrenders, and another for general iſſues.

The *Filazers* in this court, which ought to be one for each county, make the meſne proceſs after the original, in ſuing to the outlawry, and have the benefit of all copies thereof, and entries made thereupon. There has of late been but one perſon chiefly concern'd in this office, who is *Filazer* and *Exigenter* for *London* and *Middleſex*; and when you ſue by original, affidavit of your debt is to be filed with him, and here you enter the appearance, give bail, *&c.*

The Marſhal of the *King's-bench*, has the cuſtody of all priſoners, who are ſued in *Banco Regis*, and by himſelf or deputy, ought always to attend in court to receive ſuch priſoners as are committed. And every perſon ſued here, is ſuppoſed, by the declaration to be in his cuſtody; for till the *Stat.* 4, and 5. *W.* and *M.* if one was arreſted in the country, and remain'd in priſon there for want of bail, he was firſt to be removed by *Habeas Corpus* to the cuſtody of the Marſhal, before the plaintiff could declare againſt him.

The cryer of the court, makes proclamations of ſummoning and adjourning the court, calls nonſuits, and ſwears jurymen, witneſſes, *&c.*

For managing, conducting, and pleading cauſes in the court of *King's bench*, are appointed ſollicitors, attorneys, and counſellors at law.

An *Attorney* is a perſon appointed by another to do ſomething in his ſtead, particularly to ſollicit and carry on a law-ſuit.

Attorneys are ſometimes guilty of *barratry* and *champarty*. A *barrator* in law is a common mover, or maintainer of ſuits, quarrels, or parties, either in

in court or elſewhere.—*Barrators* are puniſhed by fine and impriſonment, bound to their good behaviour, &c. and being of the profeſſion of the law, ſhall be diſabled to practiſe, 34 *Edw.* III.—An attorney is in danger of being convicted of *barratry*, for maintaining another in a groundleſs action, to the commencing whereof he was no way privy, &c. and a common ſollicitor who follicits ſuits, is a common *barrator*, and may be indicted. By ſtatute no perſon ſhall take upon him any buſineſs in ſuit, to have part of the land or thing ſued for, which is called *champarty*; nor ſhall any one upon any covenant give up his right to another in ſuch caſe, on pain that the taker ſhall forfeit to the king ſo much of his lands and goods as amounts to the value of the part of the purchaſed, &c. for ſuch maintenance, *Stat.* 28. *Edw.* I. *c.* 11.—And attorneys convicted of *champarty*, ſhall ſuffer three years impriſonment, and be fined at the king's pleaſure, by 33 *Edw.* I. If any attorney undertakes or follows a cauſe to be paid in groſs, when the thing in ſuit is recovered, if he prevail therein, this has been held *champarty*.—Perſons as move pleas and ſuits as their own, are *champarters*.

Counſellor at *Law*, is a perſon learned in the law, retained by the client to plead his cauſe in a court of judicature.

Counſellors at *Law*, may alledge any thing which is informed them by their clients, if pertinent to the matter; and need not examine whether it be true or falſe; for it is at the peril of him who informs them: but after the court hath delivered their opinion of the matter depending before them, the council at the bar ought not to urge any thing further in that cauſe.

The fee of a Counſellor is *honorarium quiddam*, not *mercenarium*, as that of an attorney, or ſollicitor; ſhould be paid according to the ability of the client who employs him; ſince on his learning and eloquence, depends almoſt the whole ſucceſs of the cauſe.

No *Counſellor* ſhall ſet his hand to a frivolous plea, &c. And as counſellors have a ſpecial privilege to practiſe the law, they are puniſhable for miſbehaviour by attachment.

In *England* there are three ſorts of trials, *viz.* one by *parliament*, another by *battle*, and a third by *aſſize*, or *jury*.

The trial by *aſſize* (let the action be civil or criminal, publick or private, perſonal or real) is referred for the fact to a jury, and as they find it, ſo paſſes the judgment.

In the *general aſſize*, there are uſually many juries, becauſe there are a great many cauſes, both civil and criminal, commonly to be tried; whereof one is called the *grand jury*, and the reſt the *petit-juries*; of which it ſeems there ſhould be one in every hundred.

Grand Jury conſiſts of twenty-four good and ſubſtantial gentlemen, or ſome of the better ſort of yeomen, choſen indifferently by the ſheriff of the whole Shire, to conſider of all bills of indictment, preferred to the court; which they do either approve, by writing upon them *billa vera*; or diſallow by endorſing *ignoramus*.

Such as they do approve, if they touch life and death, are further referred to another jury, to be conſidered of, becauſe the caſe is of much importance; but others of lighter moment, are upon their allowance, without more ado, fined by the bench; except the party traverſes the indictment, or challenge it for inſufficiency; or remove the cauſe to a higher court by *Certiorari*; in which two former caſes, it is referred to another jury, and in the latter, tranſmitted to a higher bar. And preſently upon the allowance of this bill, by the grand inqueſt, a man is ſaid to be *indicted*. Such as they diſallow, are delivered to the bench, by whom they are forthwith cancelled or torn.

Petit Jury conſiſts of twelve men at leaſt, and are impannelled as well upon criminal, as upon civil cauſes. Thoſe that paſs upon offences of life and death, bring in their verdict, either guilty or not guilty; whereupon the priſoner, if he be found guilty, is ſaid to be *convicted*, and receives judgment or condemnation, or otherwiſe is acquitted and ſet free.

Thoſe that paſs upon civil cauſes real, are all, or ſo many as can conveniently be had, of the ſame hundred where the land or tenement doth lie, being four at leaſt; and they, upon due examination, bring in their verdict, either for the demandant or tenant.

The anſwer of the jury given to the court, concerning the matter of fact in any cauſe, committed by the court to their trial and examination, is called *verdict*, from *vere dictum*, q. d. *dictum veritatis*, the dictate of truth.

A *verdict* is either *general* or *ſpecial*.

General verdict, is that which is brought into the court in like general terms, as the general iſſue: as in action of diſſeiſin, the defendant pleads no wrong, no diſſeiſin.—Then the iſſue is general, whether the fact be wrong or not; which being committed to the jury, they upon conſideration of the evidence, come in and ſay, either for the plaintiff, *that it is a wrong diſſeiſin*; or for the defendant, *that it is no wrong*, no *diſſeiſin*.

Special verdict, is when they ſay at large, that ſuch and ſuch a thing they found to be done by the defendant; declaring the courſe of the fact, as

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in their opinion it is proved; and as to the law, upon the fact proving the judgment of the court.

This *ſpecial verdict*, if it contains any ample declaration of the cauſe from the beginning to the end, is called a *verdict at large*.

The *verdict* muſt anſwer the iſſue in all things, or it will not be good; but if the jury find the iſſue and more, it is good for the iſſue, and void for the reſt; and where they find a point in iſſue, and a ſuperfluops matter over, that ſhall not vitiate the *verdict*.

If a juryman withdraws from his fellows, or keeps them from giving their *verdict*, without aſſigning any reaſon, he ſhall be fined; but not if he differs from them in judgment: and if jurors eat or drink at the coſt of him for whom they give their *verdict*, before they are agreed; or caſt lots whether they ſhall find for the plaintiff, or defendant; or if they ſend for a witneſs, after gone from the bar, and he repeats his evidence again; and where a *verdict* is given contrary to the evidence, and againſt the directions of the court, *&c.* in all thoſe caſes the *verdict* may be ſet aſide.

On return of *verdicts*, in all civil caſes, given at the aſſizes, to the courts above, the judges there give judgment for the party for whom it is found.

Sir *Edward Coke* is of opinion, that the COURT OF COMMON PLEAS was conſtituted before the conqueſt.

There are four judges of this court, created by letters patent, of whom the chief is a lord by his office; and is called *dominus juſticiarius communium placitorum, vel dominus juſticiarius de banco*. And the ſeal of the court is committed to the cuſtody of the chief juſtice.

The lord chief juſtice, with his aſſiſtants, hear and determine all common pleas in civil cauſes, as diſtinguiſhed from the king's pleas: and the juriſdiction of this court is general, like that of B. R. and extends itſelf throughout *England*. It holds pleas of civil actions at common law, between ſubject and ſubject, as well actions real, as perſonal and mixed; and it ſeems to have been the only court for all real cauſes: but this court cannot regularly hold plea in any action real or perſonal, *&c.* but by writ out of chancery, returnable here; except it be by bill, for or againſt an officer, or other privileged perſon of the court.

All actions belonging to this court, come thither, either by original, or arreſt, and outlawries; or, by privilege or attachment, for or againſt privileg'd perſons; or out of inferior courts, not of record, by *pone, recordare, accedas ad curiam*, writ of falſe judgment, *&c.* And actions popular, *decies tantum*, of champarty, maintenance, *&c.* are alſo cognizable by this court; as are actions, penal of debts, *&c.* upon any ſtatute. And beſides juriſdiction for puniſhment of its officers and miniſters; the court of *common pleas*, may grant prohibitions to temporal and eccleſiaſtical courts, *&c.*

The officers of this court are, the *cuſtos brevium, prothonotaries, ſecundaries, clerk of the warrants, clerk of the eſſoins, filazers, clerk of the ſeal, exigenters, clerk of the outlawries, clerk of the juries, clerk of the treaſury, clerk of the errors, chirographer, clerk of the king's ſilver, clerk of the inrolments*, a *proclamator, cryer, tipſtaves*, and the *warden* of the *Fleet-priſon*.

The *cuſtos brevium*, is the chief clerk in this court, whoſe office is in the king's gift: he receives and keeps all writs, and puts them upon files; every return by itſelf; and at the end of each term receives of the prothonotaries all the records of the *niſi prius*, called *poſteas*.

The writs are firſt brought in by the clerks of the aſſize of every county to the prothonotary, who attend the iſſue in that matter, to enter judgment. Four days after the return the prothonotary enters the verdict and judgment thereupon, into the rolls of the court, and then delivers them over to the *cuſtos brevium*.

The *cuſtos brevium* alſo makes entry of writs of covenant, and concords on fines; and makes copies and exemplifications of all writs and records in his office, and of all fines levied; the fines, when engroſſed, are divided between the *cuſtos brevium* and chirographer, the former keeping the writ of covenant and the note, the latter the concord and foot of the fine.

The *prothonotaries* enter and inrol all declarations, pleadings, aſſizes, judgments, and actions; they alſo make out all judicial writs, as the *venire facias* after iſſue joined; *habeas corpus* for bringing in of the jury; *diſtringas juratos*, writs of execution and ſeiſin, of ſuperſedeas, of privilege, *&c.* They inrol all recognizances acknowledged in that court, all common recoveries; make exemplifications of record, *&c.*

The *ſecundaries* are aſſiſtant to the prothonotaries in the execution of their offices; and they take minutes, and draw up all orders and rules of court. Here are three *clerks of the judgments*, one under each prothonotary.

The *clerk of the warrants* enters all warrants of attorney for the plaintiffs and defendants in ſuits; and inrolls all deeds of indenture of bargain and ſale; which are acknowledged in court, or before any judge out of the court: and it is his office to eſtreat into the exchequer all iſſues, fines, and amercement, which grow due to the king in this court, for which he has a ſtanding fee, or allowance from the crown.

The

The *clerk of the eſſoins* keeps the *eſſoin roll*, or enters *eſſoins*: he alſo provides parchment, cuts it into rolls, marks the number on them, delivers out all the rolls to every officer, and receives them again when written.

The *filazers* are officers in the court of common pleas, ſo called, becauſe they file the writs, whereon they make out proceſs.

There are fourteen *filazers* in the ſeveral diviſions, and counties of *England*. They make out all writs and proceſs upon original writs, iſſuing out of the chancery, as well real, as perſonal and mixed, returnable in that court.

The *filazers* likewiſe make out all writs of view in real actions, where the view is prayed, and upon replevin's and recordari's writs of *return habenda*, ſecond deliverance, and writs of withernam.—In real actions, writs of *grand* and *petit cape* before appearance.

They enter all appearances and ſpecial bail, upon any proceſs made by them: they make the firſt *ſcire facias* upon ſpecial bails, writs of habeas corpus, *diſtringas nuper vicecomitem vel baliyum*, and *ducas tecum*; and all ſuperſedeas's upon ſpecial bail or appearance, *&c.* Writs of habeas corpus *cum cauſa*, upon the ſheriff's return that the defendant is detained with other actions; writs of adjournment of a term, in caſe of peſtilence, war, or publick diſturbance.

The *clerk of the ſeal* is an officer that ſeals all writs, judicial and miniſterial, and alſo of meſne proceſs made by the filazers; likewiſe writs of outlawry and ſuperſedeas, and all patents and exemplifications, and takes certain fees for the ſame, for which he is accountable to the maſter of this office, and the lord chief juſtice of the court.

The *exigenters* are four officers, who make out all exigents and proclamations, in all actions where the proceſs of outlawry lies, and have for every common *exigent* 1 *s.* and for every ordinary proclamation 6 *d.* but if longer than ordinary, they take in proportion to their length.

The *clerk of the outlawries* is ſervant to the attorney-general, for making out the *capias utlagatum*, on return of the exigent after outlawry, and the name of the attorney-general is to be to every one of theſe writs; and 1 *d.* only is paid for ſealing this writ, becauſe it is ſuppoſed to be at the king's ſuit; whereas 7 *d.* is paid for the ſeal of every other writ.

The *clerk of the juries* is an officer who makes out the writs called *habeas corpus*, and *diſtringas*, for the appearance of juries, either in court or at the aſſizes; after the pannel is returned upon the *venire facias*.

The *clerk of the treaſury* has the charge of keeping the records of the court, and makes up and ſeals all records of *niſi prius*: he makes all exemplifications of records lodged in the treaſury, and copies of iſſues, imparlances and judgments, and of all informations and recognizances on record there; and he has the fees due for all ſearches. He is ſervant to the chief juſtice, and is ſaid to be removeable at pleaſure; but all other officers of this court are for life: and there is an under-clerk of the treaſury for aſſiſtance, who hath ſome fees and allowances; alſo an under-keeper that keeps the keys of the treaſury-door, *&c.*

The *clerk of the errors* tranſcribes and certifies into the king's-bench the tenor of the records of the cauſe or action, upon which the writ of error, made by the curſitor, is brought there to be determined.

The *chirographer* is an officer who engroſſes fines, acknowledged in that court, into a perpetual record (after they have been examined, and paſſed by other officers) and writes and delivers the indentures thereof to the party. He makes two indentures, one for the buyer, the other for the ſeller; and a third indented piece, containing the effect of the fine, and called *the foot of the fine*; and delivers it to the *cuſtos brevium*. The ſame officer alſo, or his deputy, proclaims all fines in court every term, and endorſes the proclamations on the back-ſide of the foot; keeping withal the writ of covenant, and the note of the fine.

The *clerk of the king's ſilver* is an officer to whom every fine is brought, after it has been with the *cuſtos brevium*, and by whom the effect of the writ of covenant is entered in a paper-book; and according to that note all the fines of that term are alſo recorded in the rolls of the court.

The *clerk of the enrollments* is an officer under the three elder judges of the court of common pleas, and removable at their pleaſure.

As to the *practice* or manner of *proſecuting* ſuits in theſe ſeveral courts, they that require more knowledge thereof, may be well furniſhed by the books which are in the hands of all gentlemen practitioners in the law; it being foreign to this treatiſe to enter into the manner of proceeding upon actions in *Weſtminſter-hall*.

LOGICK.

LOGICK is the art of thinking, and reaſoning juſtly; and it conſiſts in *perception*, *judgment*, *ratiocination*, and *method*.

Perception, or *apprehenſion*, is the ſimple view of things, which offer themſelves to our mind, or whereby we only conceive a thing, without affirmation or negation; as, when we conceive the ſun, the earth, a tree, a round or ſquare, the thought, a being, without forming any expreſs judgment thereof.

Judgment is the act of our mind, whereby the ideas, which agree together, are joined by an affirmation; and thoſe, which diſagree are ſeparated by a negation, or whereby one is affirmed, or denied of the other; as, when I have the idea of God, the idea of good, and the idea of liar, I can join the idea of goodneſs with the idea of God, and remove from him the idea of a liar; in judging that God is good, and that God is not a liar.

Ratiocination is the act of our mind, whereby a judgment is formed of ſeveral preceding ones; as having judged that *true virtue* muſt be referred to God, and that the virtue of the Pagans was not referred to God; we conclude that the virtue of the Pagans was *not a true virtue*.

Method is the action of our mind, whereby having on the ſame ſubject, *viz.* the human body, various ideas, various judgments, and various reaſonings, it diſpoſes them in the moſt proper manner, to diſcover that ſubject.

From all we have ſaid on this ſubject, it follows, that *Logick* can be very well divided into four parts; the firſt of which contains *reflections on ideas*, or on *the firſt act of the mind called conception*. The ſecond *the reflections, which men have made on their judgments*. The third, *ratiocination*. The fourth, *method*.

The FIRST PART. Of SIMPLE APPREHENSION, or PERCEPTION.

If we attend carefully to what paſſes in our own minds, we ſhall obſerve two inlets of knowledge, from whence, as from two fountains, the underſtanding is ſupplied with all the materials of thinking.

Firſt, outward objects, acting upon our ſenſes, rouze in us a variety of perceptions, according to the different manner in which they affect us. It is thus that we come by the ideas of light and darkneſs, heat and cold, ſweet and bitter, and all thoſe other impreſſions which we term ſenſible qualities. This great ſource and inlet of knowledge is commonly diſtinguiſhed by the name of *Senſation*, as comprehending all the notices conveyed into the mind, by impulſes made upon the organs of ſenſe.

But theſe ideas, numerous as they be, are wholly derived to us from without; there is therefore yet another ſource of impreſſions, ariſing from the mind's attention to its own acts, when turning inwards upon itſelf, it takes a view of the *perceptions* that are lodged there, and the various ways in which it employs itſelf about them. For the ideas furniſhed by the ſenſes, give the mind an opportunity of exerting its ſeveral powers; and as all our thoughts, under whatever form they appear, are attended with conſciouſneſs, hence the impreſſions they leave, when we come to turn the eye of the ſoul upon them, enrich the underſtanding with a new ſet of *perceptions*, no leſs diſtinct than thoſe conveyed in by the ſenſes. Thus it is that we get ideas of thinking, doubting, believing, willing, *&c.* which are the different acts and workings of our minds, repreſented to us by our own conſciouſneſs. This ſecond ſource of ideas is called *reflection*, and evidently preſuppoſes ſenſation, as the impreſſions, it furniſhes, are only of the various powers of the underſtanding, employed about perceptions already in the mind.

Theſe conſiderations, if we duly attend to them, will give us a clear and diſtinct view of the natural procedure of the human intellect, in its advances to knowledge. We can have no perception of the operations of our own minds until they are exerted; nor can they be exerted before the underſtanding is furniſhed with ideas, about which to employ them; and as theſe ideas, that give the firſt employment to our faculties, are evidently the perceptions of ſenſe, it is plain, that all our knowledge muſt begin here. This then is the firſt capacity of the human mind, that it is fitted to receive the impreſſions made upon it by outward objects affecting the ſenſes; which impreſſions thus derived into the underſtanding, and *there lodged* for the view of the ſoul, employ it in various acts of perceiving, remembering, conſidering, *&c.* all which are attended with an internal feeling and conſciouſneſs. And this leads us to the ſecond ſtep the mind takes in its progreſs towards knowledge, *viz.* that it can by its own conſciouſneſs repreſent

repreſent to itſelf theſe its ſeveral workings and operations, and thereby furniſh the underſtanding with a new ſtock of ideas. From theſe ſimple beginnings, all our diſcoveries take their riſe; for the mind thus provided with its original characters and notices of things, has a power of combining, modifying, and examining them in an infinite variety of lights, by which means it is enabled to enlarge the objects of its perception, and finds itſelf poſſeſſed of an inexhauſtable ſtock of materials. It is in the various compariſon of theſe ideas, according to ſuch combinations of them as ſeem beſt to ſuit its ends, that the underſtanding exerts itſelf in the acts of judging and reaſoning, by which the capacious mind of man puſhes on its views of things, adds diſcovery to diſcovery, and often extends its thoughts beyond the utmoſt bounds of the univerſe.

It is evident from hence, that they all fall naturally under theſe two heads. *Firſt*, thoſe original impreſſions that are conveyed into the mind by *ſenſation* and *reflection*, and which exiſt there ſimple, uniform, and without any ſhadow of variety. *Secondly*, thoſe more complex notions of things that reſult from the various combinations of our *ſimple ideas*, whether they are conceived to co-exiſt of themſelves in any particular ſubject, or are united and joined together by the mind, enlarging its conceptions of things, and purſuing the ends and purpoſes of knowledge. Theſe two claſſes comprehend our whole ſtock of ideas.

The firſt claſs of our *ideas* are thoſe, which I diſtinguiſh by the name of *ſimple perception*; becauſe they exiſt in the mind under one uniform appearance, without variety or compoſition. For, tho' external objects convey at once into the underſtanding, many different ideas all united together, and making as it were one whole; yet the impreſſions themſelves are evidently diſtinct, and are conceived by the mind, each under a form peculiar to itſelf. Thus the ideas of colour, extenſion, and motion, may be taken in at one and the ſame time, from the ſame body; yet theſe three perceptions are as diſtinct in themſelves, as if they all proceeded from different objects, or were exhibited to our notice at different times. We are therefore carefully to diſtinguiſh between our *ſimple* and *primitive conceptions*, and thoſe *different combinations* of them, which are often ſuggeſted to the mind, by ſingle objects acting upon it. The firſt conſtitute our original notices of things, and are not diſtinguiſhable into different ideas, but enter by the ſenſes ſimple and unmixed. They are alſo the materials out of which all the others, how complex and complicated ſoever, are formed; and therefore ought deſervedly to be looked on as the foundation and ground-work of our knowledge.

Now if we take a ſurvey of theſe ideas, and their ſeveral diviſions and claſſes, we ſhall find them all ſuggeſted to us, either by our ſenſes, or the attention of the mind to what paſſes within itſelf. Thus, our notices of the different qualities of bodies, are all of the kind we call ſimple ideas, and may be reduced to five general heads, according to the ſeveral organs which are affected by them. Colours, *&c.* and ſounds are conveyed in by the eyes and ears; taſtes and ſmells by the noſe and palate; and heat, cold, and ſolidity, *&c.* by the touch. Beſides theſe, there are others which make impreſſions on ſeveral of our ſenſes, as extenſion, figure, reſt and motion, *&c.* the ideas of which we receive into our minds both by ſeeing and feeling.

If we next turn our view upon what paſſes within ourſelves, we ſhall find another ſet of ſimple ideas, ariſing from our conſciouſneſs of the acts and operations of our own minds. Perception or thinking, and volition or willing, are what every man experiments in himſelf, and cannot avoid being ſenſible of. I ſhall only obſerve farther, that beſides all the above-mentioned perceptions, there are others that come into our minds, by all the ways of ſenſation and reflection; ſuch are the ideas of pleaſure and pain, power, exiſtence, unity, ſucceſſion. *&c.* which are derived into our underſtandings, both by the action of objects without us, and the conſciouſneſs of what we feel within. It is true ſome of theſe ideas, as of extenſion and duration, cannot be conceived altogether without parts; nevertheleſs they are juſtly rank'd among our ſimple ideas; becauſe their parts being all of the ſame kind, and without the mixture of any other idea, neither of them can be reſolved into two diſtinct and ſeparate conceptions.

Having traced the progreſs of the mind thro' its original and ſimple ideas, until it begins to enlarge it's conceptions, by uniting and tying them together; it is time to take a ſurvey of it as thus employed in *multiplying* its views.

Whoever attentively conſiders his own thoughts, and takes a view of the ſeveral *complicated ideas*, that, from time to time, offer themſelves to his underſtanding, will readily obſerve that many of them are ſuch, as have been derived from *without*, and ſuggeſted by different objects affecting his perception; others again are formed by the *mind* itſelf, variouſly combining it's ſimple ideas, as ſeems beſt to anſwer thoſe ends and purpoſes it has, for the preſent, in view. Of the firſt kind are all our ideas of ſubſtances, as of a man, a horſe, a ſtone, gold. Of the ſecond are thoſe arbitrary collections of things, which we on many occaſions put together, either for their uſefulneſs in the commerce of life, or to further the purſuit of knowledge:

ledge: ſuch are our ideas of ſtated lengths whether of duration or ſpace, as hours, months, miles, leagues, &c. Many of our ideas of human actions may be alſo referred to this head, as treaſon, inceſt, manſlaughter, which complex notions we do not always derive from an actual view of what theſe words deſcribe, but often from combining the circumſtances of them in our own minds, or, which is the moſt uſual way, by hearing their names explained, and the ideas they ſtand for enumerated. Theſe two claſſes comprehend all our complex conceptions, it being impoſſible to conceive any, that are not either ſuggeſted to the underſtanding by ſome real exiſtences, or formed by the mind itſelf, arbitrarily uniting and compounding it's ideas.

It has been already obſerved, that the impreſſions conveyed into the underſtanding from external objects, conſiſt for the moſt part of many different ideas joined together, which all unite to make up one whole. Theſe collections of various ideas, thus co-exiſting in the ſame common ſubject, and held together by ſome unknown bond of union, have been diſtinguiſhed by the name of *ſubſtances*: a word which implies their ſubſiſting of themſelves, without dependence (at leaſt as far as our knowledge reaches) on any other created beings. Such are the ideas we have of gold, iron, water, a man, &c. For if we fix upon any one of theſe, for inſtance gold; the notion, under which we repreſent it to ourſelves, is that of a body, yellow, very weighty, hard, fuſible, malleable, &c. where we may obſerve, that the ſeveral properties, that go to the compoſition of gold, are repreſented to us by clear and evident perceptions; the union too of theſe properties, and their thereby conſiſting a diſtinct ſpecies of body, is clearly apprehended by the mind; but when we would puſh our enquiries farther, and know wherein this union conſiſts, what holds the properties together, and gives them their ſelf-ſubſiſtence, here we find ourſelves at a loſs. However, as we cannot conceive qualities, without at the ſame time ſuppoſing ſome ſubject, in which they inhere; hence we are naturally led to form the notion of a ſupport, which ſerving as a foundation for the co-exiſtence and union of the different properties of things, gives them that ſeparate and independent exiſtence, under which they are repreſented to our conception. This ſupport we denote by the name *ſubſtance*; and as it is an idea applicable to all the different combinations of qualities that exiſt any where by themſelves, they are accordingly all called *ſubſtances*. Thus a houſe, a bowl, a ſtone, &c. having each their diſtinguiſhing properties, and being conceived to exiſt independent one of another, the idea of *ſubſtance* belongs alike to them all.

In ſubſtances therefore there are two things to be conſidered: firſt the general notion of ſelf ſubſiſtence, which, as I have ſaid, belongs equally to them all; and then the ſeveral *qualities* or *properties*, by which the different kinds and individuals are diſtinguiſhed one from another. Theſe *qualities* are otherwiſe called *modes*, and have been diſtinguiſhed into *eſſential* and *accidental*, according as they are conceived to be ſeparable or inſeparable from the ſubject to which they belong. Extenſion and ſolidity are *eſſential modes* of a ſtone; becauſe it cannot be conceived without them; but roundneſs is only an *accidental mode*, as a ſtone may exiſt under any ſhape or figure, and yet ſtill retain its nature and other properties.

So that the variety of *material* ſubſtances ariſes wholly from the different configuration, ſize, texture, and motion of the minute parts. As theſe happen to be variouſly combined, and knit together under different forms, bodies put on a diverſity of appearances, and convey into the mind by the ſenſes, all thoſe ſeveral impreſſions, by which they are diſtinguiſhed one from another. This internal conſtitution or ſtructure of parts, from which the ſeveral properties that diſtinguiſh any ſubſtance flow, is called the *eſſence* of that *ſubſtance*, and is in fact unknown to us, any farther than by the perceivable impreſſions it makes upon the organs of ſenſe. Gold, as has been ſaid, is a body yellow, very weighty, hard, fuſible, malleable, &c. That inward ſtructure and conformation of its minute particles, by which they are ſo cloſely linked together, and from which the properties above-mentioned are conceived to flow, is called its *eſſence*; and the properties themſelves are the perceivable marks that make it known to us, and diſtinguiſh it from all other ſubſtances. For our ſenſes are not acute enough to reach its inward texture and conſtitution.

But many of the properties derived from this *eſſence*, make obvious and diſtinct impreſſions, as the weight, hardneſs, and yellow colour, &c. Theſe properties combined together, and conceived, as co-exiſting in the ſame common ſubject, make up our *complex idea* of gold. The ſame may be ſaid of all the other ſpecies of corporeal ſubſtances.

This however ought to be obſerved, that tho' the *eſſence* or *inward ſtructure* of *bodies*, is altogether *unknown* to us, yet we rightly judge, that in all the *ſeveral ſpecies*, the *eſſences* are diſtinct. Thus only is *true knowledge* promoted, when we argue from *known* qualities, and not from a *ſuppoſed* internal conſtitution, which however real in itſelf, yet comes not within the reach of our faculties; and therefore can never be a ground to us, for any diſcoveries or improvements.

Material substances includes the idea of solid, cohering, extended parts, and is divided into different classes, according to the different impressions made upon the organs of sense. But besides these sensible ideas received from *without*, we also experiment in ourselves thinking and volition. These actions have no connection with the known properties of body; nay, they seem plainly inconsistent with some of it's most essential qualities. For the mind, not only discovers no relation between thinking, and the motion of arrangement of parts; but it also perceives that consciousness, a simple individual act, can never proceed from a compounded substance, capable of being divided into many.

Finding therefore consciousness incompatible with the cohesion of solid separable parts, we are necessarily led to place it in some other substance, of a distinct nature and properties, which we call *spirit*.

Whatever consists of solid extended parts, is called *matter*.

But *spirit* is something altogether distinct from body, nay and commonly placed in opposition to it; for which reason, the beings of this class are called *immaterial*, a word that implies not any thing of their nature, but merely denotes its contrariety to that of matter.

Body and *spirit* therefore, differ not as species of the same substance, but are really distinct kinds of substances, and serve as general heads, under which to rank all the particular beings that fall within the compass of our knowledge. For we having no ways of perception but sense and consciousness, can have no notices of things, but as derived from these two inlets. By our senses we are informed of the existence of solid extended substances, and reflection tells us, that there are thinking conscious ones. Beyond these our conceptions reach not.

If we proceed to enquire into the ideas of the mind, we shall discover that the mind, in framing *complex ideas*, acts voluntarily and of choice; it combines only such ideas as are supposed best to suit its present purpose, and alters or changes these combinations, by inserting some, and throwing out others, according as the circumstances of things require their being viewed in different lights.

These acts may in the general be all reduced to three, as, 1. *Composition*, when we join many simple ideas together, and consider them as one picture or representation. Such are our ideas of beauty, gratitude, *&c.*

2. The next operation therefore of the mind, about its ideas, is *abstraction*; when we separate from any of our conceptions, all those circumstances, that render it *particular*, or the representative of a single determinate object; by which means, instead of standing for an individual, it is made to denote a whole rank or class of things.

3. The third and last act of the mind about its ideas, is the *comparing* them one with another; when we carry our consideration of things beyond the object themselves, and examine their *respects* and *correspondencies*, in reference to other things, which the mind brings into view at the same time.

Let us now consider the means of making known our thoughts to others, or to communicate it with the greatest certainty and advantage. For our ideas, though manifold and various, are nevertheless all within our own breasts, invisible to others, nor can of themselves be made appear. But God designing us for society, and to have fellowship with those of our kind, has provided us with organs fitted to frame articulate sounds, and given us also a capacity of using those sounds, as signs of internal conceptions. Hence spring words and language; for having once pitched upon any sound, to stand as the mark of an idea in the mind, custom by degrees establishes such a connection between them, that the appearance of the idea in the understanding, always brings to our remembrance the sound or name by which it is expressed; as in like manner the hearing of the sound, never fails to excite the idea for which it is made to stand. And thus it is easy to conceive, how a man may record his own thoughts, and bring them again into view, in any succeeding period of life. For this connection being once settled, as the same sounds will always serve to excite the same ideas; if he can but contrive to register his words, in the order and disposition, in which the present train of his thoughts presents them to his imagination; it is evident he will be able to recal these thoughts at pleasure, and that too in the very manner of their first appearance.

Besides the ability of recording our own thoughts, there is this farther advantage in the use of external signs, that they enable us to communicate our sentiments to others, and also receive information of what passes in their breasts. For any number of men, having agreed to establish the same sounds as signs of the same ideas, it is apparent that the repetition of these sounds, must excite the like perceptions in each, and create a perfect correspondence of thoughts. When for instance, any train of ideas, succeed one another in my mind, if the names by which I am wont to express them, have been annexed by those with whom I converse, to the very same set of ideas, nothing is more evident, than

that by repeating those names according to the tenor of my present conceptions, I shall raise in their minds the same course of thought as has taken possession of my own. Hence, by barely attending to what passes within themselves, they will also become acquainted with the ideas in my understanding, and have them in a manner laid before their view. So that we here clearly perceive, how a man may communicate his sentiments, knowledge, and discoveries to others, if the language, in which he converses, be extensive enough to mark all the ideas and transactions of his mind. But as this is not always the case, and men are often obliged to invent terms of their own, to express new views and conceptions of things; it may be asked, how in these circumstances we can become acquainted with the thoughts of another, when he makes use of words, to which we have never annexed any ideas, and that of course can raise no perceptions in our minds. Now, to unveil this mystery, and give some little insight into the foundation, growth, and improvement of language, the following observations will, I am apt to think, be found of considerable moment.

First, That no word can be to any man the sign of an idea, till that idea comes to have a real existence in his mind.

The first thing therefore to be consider'd is, how these ideas may be conveyed into the mind; that being there, we may learn to connect them with their appropriated sounds, and so become capable of understanding others, when they make use of these sounds in laying open and communicating their thoughts. Now to comprehend this distinctly, it will be necessary to call to mind, the before-mentioned division of our ideas into simple and complex. And first as for our simple ideas, it has been already observed, that they can find no admission into the mind, but by the two original fountains of *knowledge*, *sensation*, and *reflection*. If therefore any of these have as yet no being in the understanding, it is impossible by words or a description to excite them there. A man who had never felt the impression of *heat*, could not be brought to comprehend that sensation, by any thing we might say to explain it. The case is the same in respect of light and colours. A man born blind, can never be brought to understand the names by which they are expressed. The reason is plain: they stand for ideas that have no existence in his mind; and as the organ appropriated to their reception is wanting, all other contrivances are vain, nor can they by any force of description be raised in his imagination. But it is quite otherwise in our complex notions. For these being no more than certain combinations of simple ideas, put together in various forms; if the original ideas out of which the collections are made, have already got admission into the understanding, and the names serving to express them are known; it will be easy, by enumerating the several ideas concerned in the composition, and marking the order and manner in which they are united, to raise any complex conception in the mind. Thus the idea answering to the word *rainbow*, may be readily excited in the imagination of another, who has never seen the appearance itself, by barely describing the figure, largeness, position, and order of colours; if we suppose these several simple ideas, with their names, sufficiently known to him.

And this naturally leads me to a second observation upon this subject, namely: that words standing for *complex ideas* are all *definable*, but those by which we denote *simple ideas* are *not*. For the perceptions of this latter class, having no other entrance into the mind, than by sensation or reflection, can only be got by experience, from the several objects of nature, proper to produce those perceptions in us. The only method in this case is, to present some object, by looking at which the *perception* itself may be excited, and thus he will learn both the *name* and the *idea* together.

Thus finding, that the name *heat*, is annexed to that impression, which men feel when they approach the fire, I make it also the sign of the idea excited in me by such an approach, nor have any doubt but it denotes the same perception in my mind as in theirs. For we are naturally led to imagine, that the same objects operate alike upon the organs of the human body, and produce an uniformity of sensations.

Being furnished with simple ideas, and the names by which they are expressed, the meaning of terms that stand for *complex ideas* is easily got; because the ideas themselves answering to these terms, may be conveyed into the mind by *Definitions*.

DEFINITIONS are intended to make known the meaning of words standing for complex ideas, and were we always careful to form those ideas exactly in our minds, and copy our definitions from that appearance, much of the confusion and obscurity complained of in languages might be prevented. But unhappily for us we are by no means steady in the application of names, referring them sometimes to one thing, sometimes to another; therefore to render this whole matter as clear and obvious as possible, we shall first consider, to what it is that names, in the use of language, are most commonly applied; and then from the variety of this application,

tion, endeavour to account for the several methods of defining mentioned in the writings of Logicians.

Words then have manifestly a threefold reference. *First*, and more immediately, they denote the ideas in the mind of him, who uses them; and this is their true and proper signification. *Secondly*, we consider our words, as signs likewise of the ideas in the minds of those, with whom we converse; and this is the foundation of what is called propriety in language, when men take care to affix such notions to their words, as are commonly applied to them by those of most understanding in the country where they live. A *third* reference of words, is to things themselves. For many of our ideas, are taken from the several objects of nature, wherewith we are surrounded; and being considered as copies of things really existing, the words by which they are expressed, are often transferred from the ideas themselves, to signify those objects which they are supposed to represent. Thus the word *sun*, not only denotes the idea excited in the mind by that sound, but is also frequently made to stand for the luminous body itself, which inhabits the center of this our planetary system. Now according to this threefold application of names, their definitions, and the manner of explaining them, must be various; for it is one thing to unfold the ideas in a man's own mind, another to describe them as they are supposed to make their appearance in the minds of others; and lastly, it is something still different, to draw images or pictures, that shall carry in them a conformity to the being and reality of things.

First then, when we consider words, as signs of the ideas in the mind of him who uses them; a *definition* is nothing else, but such an explication of the meaning of any term, as that the complex idea annexed to it by the speaker, may be excited in the understanding of him with whom he converses. And this is plainly no more than teaching the connection of our words and ideas, that others may understand the sense of our expressions, and know distinctly what notions we affix to the terms we use. When we say for instance, that by the word *square*, we mean a figure bounded by four equal sides, joined together at right angles; what is this but a declaration, that the idea of a quadrilateral, equilateral, rectangular figure, is that which in discourse or writing, we connect with the term *square*? This is that kind of definition, which Logicians call the *definition of the name*; because it discovers the meaning of the words or *names* we make use of, by shewing the ideas for which they stand.

In definitions of the name, we aim at no more, than teaching the connection of words and ideas. Now the ideas we join with our words are of two kinds: either such as we have reason to believe are already in the mind of others, though perhaps they know not the names by which they are called; or such as being new and of our own formation, can no otherwise be made known than by a description. When we say that a *clock is an instrument by which we measure the hours of the day*; it is plain, that the idea answering to the word *clock*, is not here unfolded, but we being before-hand supposed to have an idea of this instrument, are only taught by what name it is called. In this sense, the names of even simple ideas may also be defined. For, by saying that *white* is the colour we observe in snow, *heat* the sensation produced by approaching the fire, we sufficiently make known what ideas we connect with the terms *white* and *heat*, which is the true purpose of a definition of the name.

But where the ideas we join with our words, are new and of our own formation, there they are to be laid open by a description. Because being supposed unknown to others, we must first raise them in their minds, before they can learn to connect them with any particular names. And here it is, that the *definition of the name* coincides with what Logicians call the *definition of the thing*, as in either case we proceed, by unfolding the idea itself, for which the term defined stands. And indeed this alone is what constitutes a definition, in the true and proper sense of the word.

This species of definitions considers words as referred to things themselves. All definitions of this kind, when justly made, are in reality pictures or representations, taken from the being and existence of things. For they are intended to express their nature and properties, so as to distinguish them from all others, and exhibit them clearly to the view of the mind.

And, from what is said, it evidently follows, that a *definition is the unfolding of some conception of the mind, answering to the word or term made use of as the sign of it.*

Definitions, considered as *descriptions* of ideas in the mind, are steady and invariable, being bounded to the representation of those precise ideas. But then in the *application* of *definitions* to particular names, we are altogether left to our own free choice. Because as the connecting of any idea, with any sound, is a perfectly arbitrary institution; the applying the description of that idea, to that sound, must be so too. When therefore Logicians tell us, that the definition of the name is arbitrary, they mean no more than this; that as different ideas may be connected with any term, according to the good pleasure of him that uses it, in like manner

manner may different deſcriptions be applied to that term, ſuitable to the ideas ſo connected. But this connection being ſettled, and the term conſidered as the ſign of ſome fixed idea in the underſtanding, we are no longer left to arbitrary explications, but muſt ſtudy ſuch a deſcription, as correſponds with that preciſe idea. Now this alone ought to be accounted a definition.

In *definitions* properly ſo called, we firſt conſider the *term* we uſe, as the ſign of ſome inward conception, either annexed to it by cuſtom, or our own free choice; and then the *buſineſs* of the definition is, to unfold and explicate that idea.

A definition is then ſaid to be perfect, when it ſerves diſtinctly to excite the idea deſcribed, in the mind of another, even ſuppoſing him before wholly unacquainted with it. This point ſettled, it is obvious that definitions cannot have place, but where we make uſe of terms, ſtanding for complex ideas. But perhaps the reader may ſtill expect, that we ſhould enter a little more particularly into the nature of a definition, deſcribe it's parts, and ſhew by what rules it ought to proceed, in order to the attainment of it's proper end.

Two things are therefore required in every *definition*. *Firſt*, that all the original ideas out of which the complex one is formed, be diſtinctly enumerated. *Secondly*, that the order and manner of combining them into one conception, be clearly explained. And to arrive at a juſt and adequate definition; *Firſt*, we are to take an exact view of the idea to be deſcribed, trace it to it's original principles, and mark the ſeveral ſimple perceptions, that enter into the compoſition of it. *Secondly*, we are to conſider the particular manner, in which theſe elementary ideas are combined, in order to the forming of that preciſe conception, for which the term we make uſe of ſtands. When this is done, and the idea wholly unravelled, we have nothing more to do, than fairly tranſcribe the appearance it makes to our own minds.

All the ideas we receive, from the ſeveral objects of nature that ſurround us, repreſent diſtinct individuals. Theſe individuals when compared together, are found in certain particulars to reſemble. Hence by collecting the reſembling particulars into one conception, we form the notion of a *ſpecies*. And here let it be obſerved, that this laſt idea is leſs complicated, than that by which we repreſent any of the particular objects contained under it. For the idea of the ſpecies excludes the peculiarities of the ſeveral individuals, and retains only ſuch properties as are common to them all. Again, by comparing ſeveral ſpecies together, and obſerving their reſemblance, we form the idea of a *genus*; where in the ſame manner as before, the compoſition is leſſened, becauſe we leave out what is peculiar to the ſeveral ſpecies compared, and retain only the particulars wherein they agree. It is eaſy to conceive the mind, proceeding thus from one ſtep to another, and advancing through its ſeveral claſſes of general notions, until at laſt it comes to the higheſt genus of all, denoted by the word *being*, where the bare idea of exiſtence is only concerned.

As therefore the firſt order of our compound notions, or the ideas that conſtitute the higheſt genera, in the different ſcales of perception, are formed, by uniting together a certain number of ſimple notices; ſo the terms expreſſing theſe genera, are defined, *by enumerating the ſimple notices ſo combined*. And as the ſpecies comprehended under any genus, or the complex ideas of the ſecond order, ariſe from ſuperadding the ſpecific difference, to the ſaid general idea; ſo the definition of the names of the ſpecies, is abſolved *in a detail of the ideas of the ſpecific difference, connected with the term of the genus*. For the *genus* having been before defined, the term by which it is expreſſed, ſtands for a known idea, and may therefore be introduced into all ſubſequent definitions, in the ſame manner as the names of ſimple perceptions. It will now I think be ſufficiently obvious, that the definitions of all the ſucceeding orders of compound notions, will every where conſiſt, *of the term of the neareſt genus, join'd with an enumeration of the ideas that conſtitute the ſpecifick difference*; and that the definition of individuals, *unites the name of the loweſt ſpecies, with the terms by the which we expreſs the ideas of the numerick difference*.

Here then we have the true and proper form of a definition, in all the various orders of conception. This is that method of defining, which is commonly called *logical*, and which we ſee is perfect in it's kind, inaſmuch as it preſents a full and adequate deſcription of the idea, for which the term defined ſtands. There are ſtill two things worthy of obſervation, before we take leave of this ſubject. Firſt that the very frame and contexture of theſe definitions, points out the order in which they ought to follow one another. For as the name of the genus is admitted into a deſcription, only in conſequence of it's having been before defined; it is evident, that we muſt paſs gradually, through all the different orders of conception. Accordingly, Logicians lay it down as a rule, that we are to begin always with the higheſt genus, and carry on the ſeries of definitions regularly, through all the intermediate genera and ſpecies, quite down to the individuals.

The

The Second Part. Of Judgment or Intuition.

When the mind is furniſhed with ideas, it's next ſtep in the way to knowledge is, the comparing theſe ideas together, in order to judge of their agreement or diſagreement. In this joint view of our ideas, if the relation is ſuch, as to be immediately diſcoverable by the bare inſpection of the mind, the judgments thence obtained are called *intuitive*, from a word that denotes *to look at*: for in this caſe, a mere attention to the ideas compared, ſuffices to let us ſee, how far they are connected or disjoined. Thus, *that the whole is greater than any of its parts*, is an intuitive judgment, nothing more being required to convince us of its truth, than an attention to the ideas of *whole* and *part*. And this too is the reaſon, why we call the act of the mind forming theſe judgments, *intuition*; as it is indeed no more, than an immediate perception of the agreement or diſagreement of any two ideas.

But our knowledge of this kind reſpects only our ideas, and the relation between them; and therefore can ſerve only as a foundation to ſuch reaſonings, as are employed in inveſtigating theſe relations. Now it ſo happens, that many of our judgments are converſant about facts, and the real exiſtence of things, which cannot be traced by the bare contemplation of our ideas. What then are the grounds of our judgment in relation to facts? I anſwer theſe two: *experience* and *teſtimony*.

By *experience* we know the exiſtence of thoſe objects that ſurround us, and fall under the immediate notice of our ſenſes. When we ſee the ſun, or caſt our eyes towards a building, we not only have ideas of theſe objects within ourſelves; but aſcribe to them a real exiſtence out of the mind. It is alſo by the information of the ſenſes, that we judge of the qualities of bodies; as when we ſay that ſnow is white, fire hot, or ſteel hard. But this is not the only advantage derived from experience, for to that too are we indebted, for all our knowledge regarding the co-exiſtence of ſenſible qualities in objects, and the operations of bodies one upon another. Ivory, for inſtance, is hard and elaſtic; this we know by experience, and indeed by that alone. In like manner with regard to the operations of bodies one upon another, it is evident, that our knowledge this way, is all derived from obſervation. *Aqua regia* diſſolves gold, as has been found by frequent trial, nor is there any other way of arriving at the diſcovery.

But there are many facts that will not allow of an appeal to the ſenſes, and in this caſe *teſtimony* is the true and only foundation of our judgments. All human actions of whatever kind, when conſidered as already paſt, are of the nature here deſcribed; becauſe having now no longer any exiſtence, both the facts themſelves, and the circumſtances attending them, can be known only from the relations of ſuch, as had ſufficient opportunities of arriving at the truth. *Teſtimony*, therefore, is juſtly accounted another ground of human judgment, from which we derive *hiſtorical knowledge*; by which I would be underſtood to mean, not merely a knowledge of the civil tranſactions of ſtates and kingdoms, but of all facts whatſoever, where teſtimony is the ultimate foundation of our belief.

Of affirmative and negative propoſitions. While the comparing of our ideas, is conſidered merely as an act of the mind, aſſembling them together, and joining or disjoining them according to the reſult of it's perceptions, we call it *judgment*; but when our judgments are put into words, they then bear the name of *propoſitions*.

A propoſition therefore is a ſentence expreſſing ſome judgment of the mind, whereby two or more ideas are affirmed to agree or diſagree. Now as our judgments include at leaſt two ideas, one of which is affirmed or denied of the other, ſo muſt a propoſition have terms anſwering to theſe ideas. The idea of which we affirm or deny, and of courſe the term expreſſing that idea, is called the *ſubject* of the propoſition. The idea affirmed or denied, as alſo the term anſwering it, is called the *predicate*. Thus in the propoſition, *God is omnipotent: God* is the ſubject, it being of him that we affirm omnipotence; and *omnipotent* is the predicate, becauſe we affirm the idea expreſſed by that word to belong to God.

But as in propoſitions, ideas are either joined or disjoined; it is not enough to have terms expreſſing thoſe ideas, unleſs we have alſo ſome words to denote their agreement or diſagreement. That word in a propoſition, which connects two ideas together, is called the *copula*; and if a negative particle be annexed, we thereby underſtand that the ideas are disjoined. The *ſubſtantive verb*, is commonly made uſe of for the *copula*, as in the above mentioned propoſition, *God is omnipotent*; where *is* repreſents the *copula*, and ſignifies the agreement of the ideas of *God* and *omnipotence*. But if we mean to ſeparate two ideas; then, beſides the ſubſtantive verb, we muſt alſo uſe ſome particle of negation, to expreſs this repugnance. The propoſition, *man is not perfect*; may ſerve as an example of this kind, where the notion of *perfection*, being removed from the idea of *man*, the negative particle *not* is inſerted after the *copula*, to ſignify the diſagreement between the ſubject and predicate.

Every

Every propoſition neceſſarily conſiſts of theſe three parts, but then it is not alike needful that they be all ſeverally expreſſed in words: becauſe the *copula* is often included in the term of the predicate, as when we ſay, *he ſits*; which imports the ſame as *he is ſitting*.

When the mind joins two ideas, we call it an *affirmative* judgment; when it ſeparates them a *negative*; and as any two ideas compared together, muſt neceſſarily either agree or not agree, it is evident, that all our judgments fall under theſe two diviſions. Hence likewiſe, the propoſitions expreſſing theſe judgments, are all either affirmative or negative. An affirmative propoſition connects the predicate with the ſubject, as *a ſtone is heavy*; a negative propoſition ſeparates them, as *God is not the author of evil*. *Affirmation* therefore is the ſame as joining two ideas together, and this is done by means of the *copula*. *Negation* on the contrary, marks a repugnance between the ideas compared, in which caſe a negative particle muſt be called in, to ſhew that the connection included in the *copula* does not take place.

Of univerſal and particular propoſitions. The next conſiderable diviſion of propoſitions, is into *univerſal* and *particular*.

An *univerſal* propoſition is that, wherein the ſubject is ſome general term, taken in it's full latitude, inſomuch that the predicate agrees to all the individuals comprehended under it, if it denotes a proper ſpecies; and to all the ſeveral ſpecies, and their individuals, if it marks an idea of a higher order. The words *all*, *every*, *no*, *none*, &c. are the proper ſigns of this univerſality; and as they ſeldom fail to accompany general truths, ſo they are the moſt obvious criterion whereby to diſtinguiſh them. *All animals have a power of beginning motion.* This is an univerſal propoſition; as we know from the word *all*, prefixed to the ſubject *animal*, which denotes that it muſt be taken in it's full extent. Hence the power of beginning motion, may be affirmed of all the ſeveral ſpecies of animals; as of birds, quadrupeds, inſects, fiſhes, &c. and of all the individuals of which theſe different claſſes conſiſt, as of this hawk, that horſe, and ſo for others.

A *particular* propoſition has in like manner ſome general term for its ſubject, but with a mark of limitation added, to denote, that the predicate agrees only to ſome of the individuals comprehended under a ſpecies, or to one or more of the ſpecies belonging to any genus, and not to the whole univerſal idea. Thus *ſome ſtones are heavier than iron*; *ſome men have an uncommon ſhare of prudence*. In the laſt of theſe propoſitions, the ſubject *ſome men*, implies only a certain number of individuals, comprehended under a ſingle ſpecies.

We have a ſure and infallible mark, whereby to diſtinguiſh between univerſal and particular propoſitions. Where the predicate agrees to all the individuals comprehended under the notion of the ſubject, there the propoſition is univerſal; where it belongs only to ſome of them, or to ſome of the ſpecies of the general idea, there the propoſition is particular. This criterion is of eaſy application, and much ſafer than to depend upon the common ſigns of *all*, *every*, *ſome*, *none*, &c. becauſe theſe being different in different languages, and often varying in their ſignification, are very apt in many caſes to miſlead the judgment.

We ſee therefore, that all propoſitions are either *affirmative* or *negative*; nor is it leſs evident, that in both caſes, they may be *univerſal* or *particular*. Hence ariſes, that celebrated fourfold diviſion of them, into *univerſal affirmative*, and *univerſal negative*; *particular affirmative*, and *particular negative*.

Of abſolute and conditional propoſitions. The objects about which we are chiefly converſant in this world, are all of a nature liable to change. What may be affirmed of them at one time, cannot often at another.

This conſideration gives riſe to the diviſion of *propoſitions* into *abſolute* and *conditional*. *Abſolute* propoſitions are thoſe, wherein we affirm ſome property inſeparable from the idea of the ſubject, and which therefore belongs to it in all poſſible caſes; as *God is infinitely wiſe*. *Virtue tends to the ultimate happineſs of man*. But where the predicate is not neceſſarily connected with the idea of the ſubject, unleſs upon ſome conſideration diſtinct from that idea, there the propoſition is called *conditional*. The reaſon of the name is taken from the ſuppoſition annexed, which is of the nature of a condition, and may be expreſſed as ſuch. Thus; *If a ſtone is expoſed to the rays of the ſun, it will contract ſome degree of heat*. *If a river runs in a very declining channel, it's rapidity will conſtantly increaſe*.

Of ſimple and compound propoſitions. Hitherto we have treated of propoſitions, where only two ideas are compared together. Theſe are in the general called *ſimple*; becauſe having but one ſubject and one predicate, they are the effect of a ſimple judgment, that admits of no ſubdiviſion. But if it ſo happens, that ſeveral ideas offer themſelves to our thoughts at once, whereby we are led to affirm the ſame thing of different objects, or different things of the ſame object; the propoſitions expreſſing theſe judgments are called *compound*: becauſe they may be reſolved into as many others;

as there are ſubjects or predicates, in the whole complex determination of the mind. Thus; *God is infinitely wiſe, and infinitely powerful.* Here there are two predicates, *infinite wiſdom*, and *infinite power*, both affirmed of the ſame ſubject; and accordingly, the propoſition may be reſolved into two others, affirming theſe predicates ſeverally. In like manner in the propoſition, *neither kings nor people are exempt from death*; the predicate is denied of both ſubjects, and may therefore be ſeparated from them, in diſtinct propoſitions. Nor is it leſs evident, that if a complex judgment conſiſts of ſeveral ſubjects and predicates, it may be reſolved into as many ſimple propoſitions, as are the number of different ideas compared together. *Riches and honours are apt to elate the mind, and increaſe the number of our deſires.* In this judgment, there are two ſubjects and two predicates, and it is at the ſame time apparent, that it may be reſolved into four diſtinct propoſitions. *Riches are apt to elate the mind. Riches are apt to increaſe the number of our deſires.* And ſo of honours.

Logicians have divided theſe compound propoſitions, into a great many different claſſes; but we reduce them to two kinds only, *viz. copulatives* and *disjunctives.*

A *copulative* propoſition is, where the ſubjects and predicates are ſo linked together, that they may be all ſeverally affirmed or denied one of another. Of this nature theſe examples. *Riches and honours are apt to elate the mind, and encreaſe the number of our deſires. Neither kings nor people are exempt from death.* In the firſt of theſe, the two predicates may be affirmed ſeverally of each ſubject, whence we have four diſtinct propoſitions. The other furniſhes an example of the negative kind, where the ſame predicate being disjoined from both ſubjects, may be alſo denied of them in ſeparate propoſitions.

Disjunctive propoſitions are theſe, in which, comparing ſeveral predicates with the ſame ſubject, we affirm that one of them neceſſarily belongs to it, but leave the particular predicate undetermined. If any one, for example, ſays: *this world either exiſts of itſelf, or is the work of ſome all wiſe and powerful cauſe*; it is evident, that one of the two predicates muſt belong to the world; but as the propoſition determines not which, it is therefore of the kind we call *disjunctive.* It is the nature of all propoſitions of this claſs, ſuppoſing them to be exact in point of form; that upon determining the particular predicate, the reſt are of courſe to be removed; or if all the predicates but one are removed, that one neceſſarily takes place.

Of the diviſion of propoſitions into ſelf-evident and demonſtrable. When any propoſition is offered to the view of the mind, if the terms in which it is expreſſed are underſtood; upon comparing the ideas together, the agreement or diſagreement aſſerted is either immediately perceived, or found to lie beyond the preſent reach of the underſtanding. In the firſt caſe the propoſition is ſaid to be *ſelf-evident*, and admits not of any proof; becauſe a bare attention to the ideas themſelves, produces full conviction and certainty; nor is it poſſible to call in any thing more evident, by way of confirmation. But where the connection or repugnance comes not ſo readily under the inſpection of the mind, there we muſt have recourſe to reaſoning; and if by a clear ſeries of proofs we can make out the truth propoſed, inſomuch that ſelf-evidence ſhall accompany every ſtep of the procedure, we are then able to demonſtrate what we aſſert, and the propoſition itſelf is ſaid to be *demonſtrable.* When we affirm for inſtance, *that it is impoſſible for the ſame thing to be and not to be*; whoever underſtands the terms made uſe of, perceives at firſt glance the truth of what is aſſerted; nor can he by any efforts, bring himſelf to believe the contrary. The propoſition therefore is *ſelf-evident*, and ſuch, that it is impoſſible by reaſoning to make it plainer; becauſe there is no truth more obvious, or better known, from which as a conſequence it may be deduced. But if we ſay, *this world had a beginning*; the aſſertion is indeed equally true, but ſhines not forth with the ſame degree of evidence. We find great difficulty in conceiving how the world could be made out of nothing; and are not brought to a free and full conſent, until by reaſoning we arrive at a clear view of the abſurdity involved in the contrary ſuppoſition. Hence this propoſition is of the kind we call *demonſtrable*, in as much as its truth is not immediately perceived by the mind, but yet may be made appear by means of others more known and obvious, whence it follows as an unavoidable conſequence.

In all propoſitions, we either affirm or deny ſome property of the idea that conſtitutes the ſubject of our judgment, or we maintain that ſomething may be done or effected. The firſt ſort are called *ſpeculative* propoſitions, as in the example, *the radii of the ſame circle are all equal one to another.* The others are called *practical*; thus, *that a right line may be drawn from one point to another*, is a practical propoſition; inaſmuch as it expreſſes that ſomething may be done.

The THIRD PART. Of RATIOCINATION, or REASONING.

The great art of *ratiocination* lies in finding out ſuch intermediate ideas, as when compared with the

the others in the queſtion, will furniſh evident and known truths; becauſe, as will afterwards appear, it is only by means of them, that we arrive at the knowledge of what is hidden and remote.

Every act of reaſoning neceſſarily includes *three* diſtinct *judgments*; two wherein the ideas whoſe relation we want to diſcover, are ſeverally compared with the middle idea, and a third wherein they are themſelves connected or disjointed, according to the reſult of that compariſon.

The expreſſions of our reaſonings are termed *ſyllogiſms*. And hence it follows, that as every act of reaſoning implies three ſeveral judgments, ſo every ſyllogiſm muſt include three diſtinct propoſitions. When a reaſoning is thus put into words, and appears in form of a ſyllogiſm, the intermediate idea made uſe of to diſcover the agreement or diſagreement we ſearch for, is called the *middle term*; and the two ideas themſelves, with which this third is compared, go by the name of the *extremes*.

Let us, for inſtance, ſet ourſelves to enquire, *whether men are accountable for their actions*. As the relation between the ideas of *man* and *accountableneſs*, comes not within the immediate view of the mind, our firſt care muſt be, to find out ſome third idea, that will enable us the more eaſily to diſcover and trace it. A very ſmall meaſure of reflection is ſufficient to inform us, that no creature can be accountable for his actions, unleſs we ſuppoſe him capable of *diſtinguiſhing* the *good* from the *bad*; that is, unleſs we ſuppoſe him poſſeſſed of *reaſon*. Nor is this alone ſufficient. For what would it avail him to know good from bad actions, if he had no *freedom of choice*, nor could avoid the one, and purſue the other? Hence it becomes neceſſary to take in both conſiderations in the preſent caſe. It is at the ſame time equally apparent, that where-ever there is this ability of diſtinguiſhing good from bad actions, and of purſuing the one and avoiding the other, there alſo a creature is *accountable*. We have then got a third idea, with which *accountableneſs* is inſeparably connected, *viz. reaſon* and *liberty*; which are here to be conſidered as making up one complex conception. Let us now take this mild idea, and compare it with the other term in the queſtion, *viz. man*, and we all know by experience, that it may be affirmed of him. Having thus by means of the intermediate idea formed two ſeveral judgments, *viz. that man is poſſeſſed of reaſon and liberty*; and, *that reaſon and liberty imply accountableneſs*; a third obviouſly and neceſſarily follows, *viz. that man is accountable for his actions*. Here then we have a compleat act of reaſoning, in which, according to what has been already obſerved, there are three diſtinct judgments; two that may be ſtiled previous, in as much as they lead to the other, and ariſe from comparing the middle idea, with the two ideas in the queſtion: the third is a conſequence of theſe previous acts, and flows from combining the extreme ideas between themſelves. If now we put this reaſoning into words, it exhibits what *Logicians* term a *ſyllogiſm*, and when propoſed in due form, runs thus:

Every creature poſſeſſed of reaſon and liberty is accountable for his actions.

Man is a creature poſſeſſed of reaſon and liberty.

Therefore man is accountable for his actions.

It will be farther neceſſary to obſerve, that as the concluſion is made up of the extreme terms of the *ſyllogiſm*, ſo that *extreme*, which ſerves as the *predicate* of the concluſion, goes by the name of the *major term*: the other *extreme*, which makes the *ſubject* in the ſame propoſition, is called the *minor term*. From this diſtinction of the extremes, ariſes alſo a diſtinction between the premiſſes, where theſe extremes are ſeverally compared with the *middle* term. That propoſition which compares the greater extreme, or the predicate of the concluſion with the middle term, is called the *major propoſition*: the other, wherein the ſame middle term is compared with the ſubject of the concluſion, or leſſer extreme, is called the *minor propoſition*. All this is obvious from the ſyllogiſm already given, where the concluſion is, *man is accountable for his actions*. For here the predicate *accountable for his actions*, being connected with the middle term in the firſt of the two premiſſes; *every creature poſſeſſed of reaſon and liberty is accountable for his actions*, gives what we call the *major propoſition*. In the ſecond of the premiſſes; *man is a creature poſſeſſed of reaſon and liberty*, we find the leſſer extreme, or ſubject of the concluſion, *viz. man*, connected with the ſame middle term, whence it is known to be the *minor propoſition*. I ſhall only add, that when a ſyllogiſm is propoſed in due form, the *major* propoſition is always placed firſt, the *minor* next, and the *concluſion* laſt.

We may in the general define reaſoning, *to be an act or operation of the mind, deducing ſome unknown propoſition, from other previous ones that are evident and known*. Theſe previous propoſitions, in a ſimple act of reaſoning, are only two in number; and it is always required, that they be of themſelves apparent to the underſtanding, inſomuch that we aſſent to and perceive the truth of them as ſoon as propoſed. In the ſyllogiſm given above, the premiſſes are ſuppoſed to be ſelf-evident truths, otherwiſe the concluſion could not be inferred by a ſingle act of reaſoning. If for inſtance in the major, *every creature poſſeſſed of reaſon and liberty is accountable for his actions*, the connection

between the ſubject and predicate could not be perceived by a bare attention to the ideas themſelves; it is evident, that this propoſition would no leſs require a proof, than the concluſion deduced from it. In this caſe a new middle term muſt be ſought for, to trace the connection here ſuppoſed; and this of courſe furniſhes another ſyllogiſm, by which having eſtabliſhed the propoſition in queſtion, we are then, and not before, at liberty to uſe it in any ſucceeding train of reaſoning. And ſhould it ſo happen that in this ſecond Eſſay there was ſtill ſome previous propoſition, whoſe truth did not appear at firſt ſight; we muſt then have recourſe to a third ſyllogiſm, in order to lay open that truth to the mind; becauſe ſo long as the premiſſes remain uncertain, the concluſion built upon them muſt be ſo too. When by conducting our thoughts in this manner, we at laſt arrive at ſome ſyllogiſm, where the previous propoſitions are *intuitive* truths; the mind then reſts in full ſecurity, as perceiving that the ſeveral concluſions it has paſſed thorough, ſtand upon the immoveable foundation of *ſelf-evidence*, and when traced to their ſource terminate in it.

The great art lies, in ſo adjuſting our ſyllogiſms one to another, that the propoſitions ſeverally made uſe of as premiſſes, may be manifeſt conſequences of what goes before. For, as by this means, every concluſion is deduced from known and eſtabliſhed truths, the very laſt in the ſeries, how far ſoever we carry it, will have no leſs certainty attending it, than the original intuitive perceptions themſelves, in which the whole chain of ſyllogiſms takes it's riſe.

Of the ſeveral kinds of reaſoning, and firſt of that by which we determine the genera and ſpecies of things. All the aims of *human reaſon* may in the general be reduced to theſe *two*: 1. To rank things under thoſe univerſal ideas to which they truly belong; and 2. To aſcribe to them their ſeveral attributes and properties in conſequence of that diſtribution.

Firſt then I ſay, that one great aim of human reaſon is, to determine the *genera* and *ſpecies* of things. As in univerſal propoſitions, we affirm ſome property of a genus or ſpecies, it is plain, that we cannot apply this property to particular objects, till we have firſt determined, whether they are comprehended under that general idea, of which the property is affirmed. Thus there are certain properties belonging to all *even* numbers, which nevertheleſs cannot be applied to any particular number, until we have firſt diſcovered it to be of the ſpecies expreſſed by that general name. Hence reaſoning begins with referring things to their ſeveral diviſions and claſſes in the ſcale of our ideas; and as theſe diviſions are all diſtinguiſhed by peculiar names, we hereby learn to apply the terms expreſſing general conceptions, to ſuch particular objects, as come under our immediate obſervation.

In order to arrive at theſe concluſions. *Firſt*, we take a view of the idea itſelf denoted by that general name, and carefully attend to the diſtinguiſhing marks which ſerve to characterize it. *Secondly*, we compare this idea with the object under conſideration, obſerving diligently wherein they agree or differ. If the idea is found to correſpond with the particular object, we then, without heſitation, apply the general name; but if no ſuch correſpondence intervenes, the concluſion muſt neceſſarily take a contrary turn. Let us for inſtance take the number *eight*, and conſider by what ſteps we are led to pronounce it an *even* number. Firſt then we call to mind the idea ſignified by the expreſſion *an even number*, viz. that it is *a number diviſible into two equal parts*. We then compare this idea with the number *eight*, and finding them manifeſtly to agree, ſee at once the neceſſity of admitting the concluſion. Theſe ſeveral judgments therefore, transferred into language, and reduced to the form of a ſyllogiſm, appear thus:

Every number that may be divided into two equal parts is an EVEN *number.*

The number EIGHT *may be divided into two equal parts.*

Therefore the number EIGHT *is an* EVEN *number.*

Of Reaſoning, *as it regards the* powers *and* properties *of things, and the* relations *of our* general ideas. Here it will be neceſſary to diſtinguiſh between *reaſoning* as it regards the *ſciences*, and as it concerns *common life*.

In the ſciences, our reaſon is employed chiefly about univerſal truths, it being by them alone, that the bounds of human knowledge are enlarged. Hence the diviſion of things into various claſſes, called otherwiſe *genera* and *ſpecies*. For theſe univerſal ideas, being ſet up as the repreſentatives of many particular things, whatever is affirmed of them, may be alſo affirmed of all the individuals to which they belong. *Murder* for inſtance is a general idea, repreſenting a certain ſpecies of human actions. Reaſon tells us that the puniſhment due to it is *death*. Hence every particular action coming under the notion of *murder*, has the puniſhment of *death* allotted to it. Here then we apply the general truth to ſome obvious inſtance, and this is what properly conſtitutes the reaſoning of common life.

The

The ſteps by which we proceed, in the reaſoning of common life, are, *Firſt*, refer the object under conſideration to ſome general idea or claſs of things; then to recollect the ſeveral attributes of that general idea: and laſtly, to aſcribe all thoſe attributes to the preſent object. Thus, in conſidering the character of *Sempronius*, if we find it to be of the kind called *virtuous*; when we at the ſame time reflect, that a *virtuous* character is deſerving of eſteem, it naturally and obviouſly follows, that *Sempronius* is ſo too. Theſe thoughts put into a *ſyllogiſm*, in order to exhibit the form of reaſoning here required, run thus.

Every virtuous man is worthy of eſteem.
SEMPRONIUS *is a virtuous man.*
Therefore SEMPRONIUS *is worthy of eſteem.*

The determining the *genera* and *ſpecies* of things, is, as we have ſaid, one exerciſe of human reaſon; and here we find, that this exerciſe is the firſt in order, and previous to the other, which conſiſts in aſcribing to them their powers, properties, and relations. But when we have taken this previous ſtep, and brought particular objects under general names; as the properties we aſcribe to them are no other than thoſe of the general idea, it is plain, that in order to a ſucceſsful progreſs in this part of knowledge, we muſt thoroughly acquaint ourſelves with the ſeveral *relations* and *attributes* of theſe our general ideas.

The *relations* of our *general ideas* are of two kinds; either ſuch as immediately diſcover themſelves, upon comparing the ideas one with another; or ſuch, as being more remote and diſtant, require art and contrivance to bring them into view. The relations of the firſt kind, furniſh us with intuitive and ſelf-evident truths: thoſe of the ſecond, are traced by reaſoning, and a due application of intermediate ideas. It is evident therefore, that to make a good reaſoner, two things are principally required: *Firſt*, an extenſive knowledge of thoſe intermediate ideas, by means of which, things may be compared one with another. *Secondly*, the ſkill and talent of applying them happily, in all particular inſtances that come under conſideration.

Of the FORMS *of* SYLLOGISMS. Hitherto we have contented ourſelves with a *general notion* of *ſyllogiſms*, and of the *parts* of which they conſiſt. It is now time to enter a little more particularly into the ſubject, to examine their various forms, and lay open the rules of argumentation proper to each.

In the ſyllogiſms already mentioned, we may obſerve, that the *middle term* is the ſubject of the *major* propoſition, and the predicate of the *minor*. This diſpoſition, though the moſt natural and obvious, is not however neceſſary; it frequently happening, that the *middle term* is the ſubject in both the premiſſes, or the predicate in both; and ſometimes, the predicate in the *major*, and the ſubject in the *minor*.

Hence the diſtinction of ſyllogiſms into various kinds, called *figures* by *Logicians*. For, *figure*, according to their uſe of the word, is nothing elſe, but the order and diſpoſition of the *middle term* in any ſyllogiſm. And as this diſpoſition, is *four-fold*, ſo the figures of ſyllogiſms thence ariſing, are *four* in number.

When the *middle term* is the ſubject of the *major* propoſition, and the predicate of the *minor*, we have what is called the *firſt figure*. If on the other hand, it is the predicate of both the premiſſes, the ſyllogiſm is ſaid to be in the *ſecond figure*. Again in the *third figure*, the *middle term* is the ſubject of the two premiſſes. And laſtly, by making it the predicate of the *major*, and ſubject of the *minor*, we obtain ſyllogiſms in the *fourth figure*.

But beſides this four-fold diſtinction of ſyllogiſms, there is alſo a farther ſubdiviſion of them in every figure, ariſing from the *quantity* and *quality* as they are called of the propoſitions. By *quantity* we mean the conſideration of propoſitions as univerſal or particular, by *quality* as affirmative or negative.

Now as in all the ſeveral diſpoſitions of the *middle term*, the *propoſitions* of which a ſyllogiſm conſiſts, may be either *univerſal* or *particular*, *affirmative* or *negative*; the due determination of theſe, and ſo putting them together, as the laws of argumentation require, conſtitute what *Logicians* call the *moods* of ſyllogiſms.

Of theſe *moods* there are a determinate number to every figure, including all the poſſible ways, in which propoſitions differing in *quantity* or *quality* can be combined, according to any diſpoſition of the *middle term*, in order to arrive at a juſt concluſion. See the *Port-Royal art of thinking*, where the *moods* and *figures* of ſyllogiſms are diſtinctly explained, and the rules proper to each, are very neatly demonſtrated.

When in any ſyllogiſm, the *major* is a *conditional* propoſition, the ſyllogiſm itſelf is termed *conditional*, thus:

If there is a God, he ought to be worſhipped.
But there is a God:
Therefore he ought to be worſhipped.

In this example, the *major* or firſt propoſition, is, we ſee, *conditional*, and therefore the ſyllogiſm itſelf is alſo of the kind, called by that name.

And

And here we are to obſerve, that all conditional propoſitions are made up of two diſtinct parts: one expreſſing the condition upon which the predicate agrees or diſagrees with the ſubject, as in this now before us, *if there is a God*; the other joining or diſjoining the ſaid predicate and ſubject, as here, *he ought to be worſhipped*. The firſt of theſe parts, or that which implies the condition, is called the *antecedent*; the ſecond, where we join or diſjoin the predicate and ſubject has the name of the *conſequent*.

When any *conditional* propoſition is aſſumed, if we admit the antecedent of that propoſition, we muſt at the ſame time neceſſarily admit the conſequent; but if we reject the conſequent, we are in like manner bound to reject alſo the antecedent. For as the antecedent always expreſſes ſome condition, which neceſſarily implies the truth of the conſequent; by admitting the antecedent we allow of that condition, and therefore ought alſo to admit the conſequent. In like manner if it appears that the conſequent ought to be rejected, the antecedent evidently muſt be ſo too; becauſe as was juſt now demonſtrated, the admitting of the antecedent, would neceſſarily imply the admiſſion alſo of the conſequent.

Hence it appears, that there are two ways of arguing in *hypothetical* ſyllogiſms, which lead to a certain and unavoidable concluſion. For, as the *major* is always a conditional propoſition, conſiſting of an antecedent and a conſequent; if the *minor* admits the antecedent, it is plain that the concluſion muſt admit the conſequent. This is called arguing from the admiſſion of the antecedent, to the admiſſion of the conſequent, and conſtitutes that mood or ſpecies of *hypothetical* ſyllogiſms, which is diſtinguiſhed in the ſchools by the name of the *modus ponens*, in as much as by it, the whole conditional propoſition, both antecedent and conſequent, is eſtabliſhed. Thus:

If God is infinitely wiſe, and acts with perfect freedom, he does nothing but what is beſt.
But God is infinitely wiſe, and acts with perfect freedom.
Therefore he does nothing but what is beſt.

Here we ſee the antecedent or firſt part of the conditional propoſition is eſtabliſhed in the *minor*, and the conſequent or ſecond part in the concluſion; whence the ſyllogiſm itſelf is an example of the *modus ponens*. But if now we on the contrary ſuppoſe, that the *minor* rejects the conſequent, then it is apparent, that the concluſion muſt alſo reject the antecedent. In this caſe we are ſaid to argue from the removal of the conſequent, to the removal of the antecedent, and the particular mood or ſpecies of ſyllogiſms thence ariſing, is called by Logicians the *modus tollens*; becauſe in it, both antecedent and conſequent, are rejected or taken away, as appears by the following example.

If God were not a Being of infinite goodneſs, neither would he conſult the happineſs of his creatures.
But God does conſult the happineſs of his creatures;
Therefore he is a Being of infinite goodneſs.

Theſe two ſpecies take in the whole claſs of *conditional* ſyllogiſms, and include all the poſſible ways of arguing that lead to a legitimate concluſion.

As from the *major*'s being a *conditional* propoſition, we obtain the ſpecies of *conditional* ſyllogiſms; ſo where it is a *diſjunctive* propoſition, the ſyllogiſm to which it belongs is alſo called *diſjunctive*.

The world is either ſelf-exiſtent, or the work of ſome finite, or of ſome infinite Being.
But it is not ſelf-exiſtent, nor the work of a finite Being.
Therefore it is the work of an infinite Being.

Now a diſjunctive propoſition is that, where of ſeveral predicates, we affirm one neceſſarily to belong to the ſubject, to the excluſion of all the reſt, but leave that particular one undetermined. Hence it follows, that as ſoon as we determine the particular predicate, all the reſt are of courſe to be rejected; or if we reject all the predicates but one, that one neceſſarily takes place. When therefore in a *diſjunctive* ſyllogiſm, the ſeveral predicates are enumerated in the *major*; if the *minor* eſtabliſhes any one of theſe predicates, the concluſion ought to remove all the reſt; or if in the *minor*, all the predicates but one are removed, the concluſion muſt neceſſarily eſtabliſh that one.

Thus in the *diſjunctive* ſyllogiſm given above, the *major* affirms one of three predicates to belong to the earth, *viz. Self-exiſtence*, or that it is *the work of a finite*, or that it is *the work of an infinite Being*. Two of theſe predicates are removed in the *minor*, *viz. Self-exiſtence*, and *the work of a finite Being*. Hence the concluſion neceſſarily aſcribes to it the third predicate, and affirms, that it is *the work of an infinite Being*. If now we give the ſyllogiſm another turn, inſomuch that the *minor* may eſtabliſh one of the predicates, by affirming the earth to be *the production of an infinite Being*; then the concluſion muſt remove the other two, aſſerting it to be neither *ſelf-exiſtent*, nor *the work of a finite Being*. Theſe are the forms of reaſoning in this ſpecies of ſyllogiſms.

It often happens, that ſome one of the premiſſes is not only an evident truth, but alſo familiar, and in the minds of all men; in which caſe it is uſually omitted, whereby we have an imperfect ſyllogiſm that

that ſeems to be made up of only two propoſitions. Should we for inſtance argue in this manner:

Every man is mortal;
Therefore every king is mortal.

The ſyllogiſm appears to be imperfect, as conſiſting but of two propoſitions. Yet it is really compleat, only the *minor* [*Every king is a man*] is omitted, and left to the reader to ſupply, as being a propoſition ſo familiar and evident, that it cannot eſcape him.

Theſe ſeemingly imperfect ſyllogiſms are called *enthymemes*.

There is another ſpecies of reaſoning with two propoſitions, which ſeems to be compleat in itſelf, and where we admit the concluſion, without ſuppoſing any tacit or ſuppreſſed judgment in the mind, from which it follows ſyllogiſtically.

Thus by admitting an *univerſal* propoſition, we are forced alſo to admit of all the *particular* propoſitions comprehended under it. Whoever allows, for inſtance, *that things equal to one and the ſame thing are equal to one another*, muſt at the ſame time allow, *that two triangles, each equal to a ſquare whoſe ſide is three inches, are alſo equal between themſelves*. This argument therefore,

Things equal to one and the ſame thing are equal to one another;
Therefore theſe two triangles, each equal to the ſquare of a line of three inches, are equal between themſelves;

is compleat in its kind, and contains all that is neceſſary towards a juſt and legitimate concluſion.

The next ſpecies of reaſoning we ſhall take notice of, is what is known by the name of a *ſorites*; in which a great number of propoſitions are ſo linked together, that the predicate of one, becomes continually the ſubject of the next following, until at laſt a concluſion is formed, by bringing together the ſubject of the firſt propoſition, and the predicate of the laſt. Of this kind is the following argument.

God is omnipotent.
An omnipotent being can do every thing poſſible.
He that can do every thing poſſible, can do whatever involves not a contradiction.
Therefore God can do whatever involves not a contradiction.

This particular combination of propoſitions, may be continued to any length we pleaſe, without in the leaſt weakening the ground upon which the concluſion reſts. The reaſon is, becauſe the *ſorites* itſelf may be reſolved into as many ſimple ſyllogiſms as there are middle terms in it; where this is found univerſally to hold, that when ſuch a reſolution is made, and the ſyllogiſms are placed in train, the concluſion of the laſt in the ſeries, is alſo the concluſion of the *ſorites*.

What is here ſaid of plain *ſimple* propoſitions, may be as well applied to thoſe that are *conditional*; that is, any number of them may be ſo joined together in a ſeries, that the conſequent of one, ſhall become continually the antecedent of the next following; in which caſe, by eſtabliſhing the antecedent of the firſt propoſition, we eſtabliſh the conſequent of the laſt, or by removing the laſt conſequent, remove alſo the firſt antecedent. This way of reaſoning is exemplified in the following argument.

If we love any perſon, all emotions of hatred towards him ceaſe.
If all emotions of hatred towards a perſon ceaſe, we cannot rejoice in his misfortunes.
If we rejoice not in his misfortunes, we certainly wiſh him no injury.
Therefore if we love a perſon, we wiſh him no injury.

I come now to that kind of argument, which Logicians call *induction*; in order to the right underſtanding of which, it will be neceſſary to obſerve, that our *general ideas* are for the moſt part capable of various *ſubdiviſions*. Thus the idea of the loweſt *ſpecies*, may be ſubdivided into its ſeveral individuals; the idea of any *genus*, into the different ſpecies it comprehends; and ſo of the reſt.

Thus if we ſuppoſe the whole tribe of animals, ſubdivided into men, beaſts, birds, inſects and fiſhes, and then reaſon concerning them after this manner: *All men have a power of beginning motion; all beaſts, birds, and inſects, have a power of beginning motion; all fiſhes have a power of beginning motion; therefore all animals have a power of beginning motion*: the argument is an *induction*. When the ſubdiviſions are juſt, ſo as to take in the whole general idea, and the enumeration is perfect, that is, extends to all and every of the inferior claſſes or parts; there the *induction* is compleat, and the manner of reaſoning by *induction*, is apparently concluſive.

The laſt ſpecies of ſyllogiſms I ſhall take notice of, is diſtinguiſhed by the name of a *dilemma*.

A *dilemma* is an argument, by which we endeavour to prove the abſurdity or falſhood of ſome aſſertion. In order to this we aſſume a *conditional* propoſition, the antecedent of which is the aſſertion to be diſproved, and the conſequent a *diſjunctive* propoſition, enumerating all the poſſible ſuppoſitions, upon which that aſſertion can take place. If then it appear, that all theſe ſeveral ſuppoſitions ought to be rejected, it is plain, that the antecedent

or aſſertion itſelf muſt be ſo too. When therefore ſuch a propoſition, as that before mentioned, is made the *major* of any ſyllogiſm; if the *minor* rejects all the ſuppoſitions contained in the conſequent; it follows neceſſarily, that the concluſion ought to reject the antecedent, which, as we have ſaid, is the very aſſertion to be diſproved. From this account it appears, that we may in the general define it, to be *a hypothetical ſyllogiſm, where the conſequent of the major is a disjunctive propoſition; which is wholly taken away or removed in the minor.* Of this kind is the following:

If God did not create the world perfect in its kind, it muſt either proceed from want of inclination, or from want of power.

But it could not proceed either from want of inclination, or from want of power.

Therefore he created the world perfect in its kind.

Or, which is the ſame thing: *'tis abſurd to ſay that he did not create the world perfect in its kind.*

The nature then of a *dilemma*.

The *major* is a conditional propoſition, whoſe conſequent contains all the ſeveral ſuppoſitions upon which the antecedent can take place. As therefore theſe ſuppoſitions are wholly removed in the *minor*, it is evident that the antecedent muſt be ſo too; inſomuch that we here always argue from the removal of the conſequent, to the removal of the antecedent. That is, a *dilemma* is an argument, in the *modus tollens* of hypothetical ſyllogiſms, as Logicians love to ſpeak. Hence it is plain, that if the antecedent of the *major* is an affirmative propoſition, the concluſion of the *dilemma* will be negative; but if it is a negative propoſition, the concluſion will be affirmative.

As to the *fallacy of ſophiſms*. Though when one knows the rules of good reaſoning, it is not difficult to diſcover thoſe which are bad, notwithſtanding as the examples to be avoided make often a greater impreſſion on our mind than thoſe to be imitated, it will not be needleſs to repreſent the principal ſources of bad reaſoning, called *ſophiſms* or *paralogiſms*. I'll reduce them all to eight or nine.

The firſt is *to prove another thing than what is in queſtion*. *Paſſion*, or want of probity, cauſes one to attribute to his adverſary, what is often very far from his ſentiment, to take occaſion hence to fight him with more advantage, or to impute to him the conſequences he imagines he can draw from his doctrine, though at the ſame time he denies them.

The ſecond is *to ſuppoſe for true what is in queſtion*. This is what *Ariſtotle* calls *petition of principle*, and which we ſee clearly enough, to be contrary to true reaſon; becauſe in all reaſoning what ſerves for proof muſt be clearer and better known than what is to be proved.

Notwithſtanding which *Ariſtotle* is accuſed by *Galileo*, and with juſtice, to have himſelf been guilty of that imperfection, when he wanted to prove by the following argument, that the earth is placed in the center of the world.

The nature of ponderous things is to tend towards the center of the world, and of light things to depart from it.

But experience ſhews us, that ponderous things tend towards the center of the earth, and light things depart from it:

Therefore the center of the earth is the center of the world.

It is clear, that there is in the major of this argument a manifeſt *petition of principle*; for we ſee very well, that ponderous things tend towards the center of the earth: but whence has *Ariſtotle* took, that they tend towards the center of the world; unleſs he ſuppoſes that the center of the earth is the ſame with the center of the world; which is the very concluſion he would prove by that argument.

The third is *to take for a cauſe which is not a cauſe*. This ſophiſm is very common. Philoſophers have attributed a thouſand effects to the fear of the vacuum, which has been proved demonſtratively by very ingenious experiences, to have for cauſe but the ponderoſity of the air.

The fourth is *an imperfect enumeration*. As if any body was to ſay, *Titius is condemned to die, or by his own fault, or by the partiality of the judges*; this enumeration would be imperfect, for it could happen likewiſe, that *Titius* is condemned to die, or by want of probity in the witneſſes, or ſome miſtakes in his defence, or the like.

The fifth is, *to judge of a cauſe by what belongs to it, but by accident*. As if ſome body would exclude *antimony* from among remedies, becauſe having been ſometimes unſkilfully adminiſtred, it has produced bad effects.

The ſixth is *to paſs from a divided ſenſe to a compoſite ſenſe, and from a compoſite ſenſe to a divided ſenſe*.

One of theſe ſophiſms is called *fallacia compoſitionis*, and the other *fallacia diviſionis*. It is what will be eaſier underſtood by examples.

God juſtifies the impious; cannot be ſaid, that he accounts for juſt thoſe, who are impious ſtill, but that he renders juſt, by his grace thoſe, who were impious before.

There are on the contrary propoſitions, which are not true, but in a ſenſe oppoſite to that which is a divided ſenſe: As when St. *Paul* ſays, that fornicators, *&c.* ſhall not enter into the kingdom of heaven; for this does not ſignify that none of thoſe, who have been guilty of thoſe vices will be ſaved, but only that thoſe, who will *not renounce* them by a ſincere repentance, and their converſion to God, ſhall have no part in the kingdom of heaven.

The ſeventh is *to paſs from what is true in ſome reſpect, to what is ſimply true.* This is called in the ſchools, *a dicto ſecundum quid ad dictum ſimpliciter*; of which I'll give the following examples.

The *Epicureans* wanted to prove, that the gods ſhould have a human form, becauſe there was no handſomer than that, and that all that's handſome muſt be in God; which was a very bad reaſon. For the human form is not abſolutely a beauty, but only with regard to the bodies; and therefore it being a perfection, but in ſome reſpect and not ſimply, it does not follow hence that it muſt be in God, becauſe all perfections are in God; none but thoſe, which are ſimple perfections, *i. e.* which include no imperfections being neceſſarily in God.

The eighth is *to abuſe the ambiguity of words.* To this ſort of *ſophiſm* can be referred all the ſyllogiſms, which are vicious for having four terms; either becauſe the medium is taken twice particularly, or becauſe it is taken in one ſenſe in the firſt propoſition, and in another ſenſe in the ſecond; or, laſtly, becauſe the terms of the concluſion are not taken in the ſame ſenſe in the premiſſes, as in the concluſion.

Such is that found in the words, which ſignify a *whole*, which can be taken collectively for all its parts together, or diſtributively for each of its parts. It is whereby this *ſophiſm* of the *Stoicks* is to be reſolved, who concluded that the world was an animal endued with reaſon; *becauſe what has the uſe of reaſon, is better than that, which has not that uſe; but nothing is better*, ſaid they, *than the world; therefore the world has the uſe of reaſon.* The minor of this argument is falſe, becauſe they attributed to the world what only belongs to God; which is to be ſuch, that nothing can be conceived better and more perfect. But in confining ones ſelf in the creatures, though it can be ſaid that nothing is better than the world, taken collectively for the univerſality of all the beings God has created, all that can be concluded from it, is, that the world has the uſe of reaſon according to ſome of its parts, ſuch as the angels and men; but not that altogether he is an animal which has the uſe of reaſon.

The Fourth Part. Of Method.

It is the true and proper buſineſs of *method* to aſcertain the various diviſions of human knowledge, and ſo to adjuſt and connect the parts in every branch, that they may ſeem to grow one out of another, and form a regular body of ſcience, riſing from firſt principles, and proceeding by an orderly concatenation of truths.

In this view of things we muſt be well acquainted with the truths we are to combine together; otherwiſe how could we diſcern their ſeveral connections and relations, or ſo diſpoſe of them as their mutual dependence may require. But as it often happens, that the underſtanding is employed, not in the arrangement and compoſition of known truths, but in the ſearch and diſcovery of ſuch as are unknown: let us ſuppoſe a watch preſented to us, whoſe ſtructure and compoſition we are as yet unacquainted with, but want if poſſible to diſcover. The manner of proceeding in this caſe is, by taking the whole to pieces, and examining the parts ſeparately one after another. When by ſuch a ſcrutiny we have thoroughly informed ourſelves of the frame and contexture of each, we then compare them together, in order to judge of their mutual action and influence. By this means we gradually trace out the inward make and compoſition of the whole, and come at length to diſcern, how the parts of ſuch a form, and ſo put together as we found, in unraveling and taking them aſunder, conſtitute that particular machine called a watch, and contribute to all the ſeveral motions and phænomena obſervable in it. This diſcovery being made, we can take things the contrary way, and, beginning with the parts, ſo diſpoſe and connect them, as their ſeveral uſes and ſtructures require, until at length we arrive at the whole itſelf, from the unraveling of which theſe parts reſulted.

As it is in tracing and examining the works of art, ſo is it in a great meaſure in unfolding any part of human knowledge. For the relations and mutual habitudes of things do not always immediately appear, upon comparing them one with another. Hence we have recourſe to intermediate ideas, and by means of them are furniſhed with thoſe previous propoſitions, that lead to the concluſion we are in queſt of. And if it ſo happen, that the previous propoſitions themſelves are not ſufficiently evident, we endeavour by new middle terms to aſcertain their truth, ſtill tracing things backward in a continued ſeries, until at length we arrive at ſome ſyllogiſm, where the premiſſes are firſt and ſelf-evident principles.

Hence it appears, that in diſpoſing and putting together our thoughts, either for our own uſe, that

the diſcoveries we have made may at all times lie open to the review of the mind; or where we mean to communicate and unfold theſe diſcoveries to others, there are two ways of proceeding equally within our choice. For we may ſo propoſe the truths relating to any part of knowledge, as they preſented themſelves to the mind in the manner of inveſtigation, carrying on the ſeries of proofs in a reverſe order, until they at laſt terminate in firſt principles: or beginning with theſe principles, we may take the contrary way, and from them deduce, by a direct train of reaſoning, all the ſeveral propoſitions we want to eſtabliſh.

This diverſity in the manner of arranging our thoughts, gives riſe to the twofold diviſion of method eſtabliſhed among *Logicians*. For, *method*, according to their uſe of the word, is nothing elſe but *the order and diſpoſition of our thoughts relating to any ſubject*. When truths are ſo propoſed and put together, as they were or might have been diſcovered, this is called the *analytick method*, or the *method of reſolution*; in as much as it traces things backward to their ſource, and *reſolves* knowledge into its firſt and original principles. When on the other hand they are deduced from theſe principles, and connected according to their mutual dependance, inſomuch that the truths, firſt in order, tend always to the demonſtration of thoſe that follow, this conſtitutes what we call the *ſynthetick method*, or *method of compoſition*. For here we proceed by gathering together the ſeveral ſcattered parts of knowledge, and *combining* them into one whole or ſyſtem, in ſuch manner, that the underſtanding is enabled diſtinctly to follow truth, thro' all her different ſtages and gradations.

The firſt has alſo obtained the name of the *method of invention*; becauſe it obſerves the order in which our thoughts ſucceed one another in the *invention* or diſcovery of truth. The other is often denominated the *method of doctrine* or *inſtruction*, in as much as in laying our thoughts before others, we generally chuſe to proceed in the *ſynthetic* manner, deducing them from their firſt principles. Hence it is, that we chuſe to diſtinguiſh it by the name of the *method of ſcience*; not only as in the uſe of it we arrive at *ſcience* and certainty; but, becauſe it is in fact the method, in which all thoſe parts of human knowledge, that properly bear the name of *ſciences*, are and ought to be delivered.

Of the method of invention. By the *method of invention* we underſtand ſuch a diſpoſition and arrangement of our thoughts, as follows the natural procedure of the underſtanding, and preſents them in the order in which they ſucceed one another in the inveſtigation and diſcovery of truth. When the mind reſts ſatisfied in a bare contemplation of the rules, and the reaſons on which they are founded, this kind of knowledge is called *ſpeculative*. But if we proceed farther, and endeavour to apply theſe rules to *practice*, ſo as to acquire a habit of exerting them on all proper occaſions, we are then ſaid to be poſſeſſed of the *art* itſelf.

In the exerciſe of invention, two things are of principal conſideration. *Firſt*, an enlarged and comprehenſive underſtanding, able to take in the great multitude of particulars, that frequently come under our notice. *Secondly*, a ſtrong habit of attention, that lets nothing remarkable ſlip its view, and diſtinguiſhes carefully all thoſe circumſtances, which tend to the illuſtrating and clearing the ſubject we are upon. Theſe are the great and preparatory qualifications, without which it were in vain to hope, that any conſiderable advance could be made, in enlarging the bounds of human knowledge.

Furniſhed with theſe two *preparatory qualifications*, the next requiſite to the diſcovery of truth is, a judicious choice of intermediate ideas. Now altho' this happy choice of intermediate ideas, ſo as to furniſh a due train of previous propoſitions, that ſhall lead us ſucceſſively from one diſcovery to another, depends in ſome meaſure upon a natural ſagacity and quickneſs of mind; it is yet certain from experience, that even here much may be effected, by a ſtubborn application and induſtry. In order to this it is in the firſt place neceſſary, that we have an extenſive knowledge of things, and ſome general acquaintance with the whole circle of arts and ſciences. And if to this we join in the ſecond place, a more particular and intimate ſtudy of whatever relates to the ſubject about which our enquiries are employed, we ſeem to bid fair for ſucceſs in our attempts.

Much ſtill depends upon a certain dexterity and addreſs, in ſingling out the moſt proper, and applying them ſkilfully for the diſcovery of truth. This is that talent, which is known by the name of *ſagacity*, and commonly ſuppoſed to be altogether the gift of nature. But yet I think it is beyond diſpute, that practice, experience, and a watchful attention to the procedure of our own minds while employed in the exerciſe of reaſoning, are even here of very great avail. It is a truth well known to thoſe who have made any conſiderable progreſs in the ſtudy of Algebra, that an addreſs and ſkill in managing intricate queſtions, may be very often obtained, by a careful imitation of the beſt models.

Though

Though the capacity of the intellect may be greatly enlarged by uſe and exerciſe, yet ſtill our views are confined within certain bounds, beyond which a finite underſtanding cannot reach. And as it often happens in the inveſtigation of truth, eſpecially where it lies at a conſiderable diſtance from firſt principles, that the number of connections and relations are ſo great, as not to be taken in at once by the moſt improved underſtanding; it is therefore one great branch of the art of invention, to take account of theſe relations as they come into view, and diſpoſe of them in ſuch manner, that they may always lie open to the inſpection of the mind, when diſpoſed to turn its attention that way.

By carrying our attention ſucceſſively from one part to another, we can upon occaſion take in the whole; and knowing alſo the order and diſpoſition of the parts, may have recourſe to any of them at pleaſure, when its aid becomes neceſſary in the courſe of our enquiries.

Firſt, an *orderly combination* of things, and *claſſing* them together with art and addreſs, brings great and otherwiſe unmanageable objects, upon a level with the powers of the mind.

It is of principal conſideration in the buſineſs of *invention*, to have our thoughts ſo much under command, that in comparing things together, in order to diſcover the reſult of their mutual connections and dependence, all the ſeveral lights that tend to the clearing the ſubject we are upon, may lie diſtinctly open to the underſtanding, ſo as nothing material ſhall eſcape its view: becauſe an overſight of this kind in ſumming up the account, muſt not only greatly retard its advances, but in many caſes check its progreſs altogether.

Secondly, another advantage ariſing from this orderly diſpoſition is, that hereby we free the mind from all unceſſary fatigue, and leave it to fix its attention upon any part ſeparately, without perplexing itſelf with the conſideration of the whole.

The mind, proceeding gradually thro' the ſeveral relations of its ideas, and marking the reſults of them at every ſtep, can always proportion its enquiries to its ſtrength; and confining itſelf to ſuch a number of objects, as it can take in and manage at eaſe, ſees more diſtinctly all the conſequences that ariſe from comparing them one with another. When therefore, it comes afterwards to take a review of theſe its ſeveral advances, as by this means the amount of every ſtep of the inveſtigation is fairly laid open to its inſpection, by adjuſting and putting theſe together in due order and method, it is enabled at laſt to diſcern the reſult of the whole.

There are two great branches of the *mathematicks*, peculiarly fitted to furniſh us with models in this way: *arithmetick* I mean, and *algebra*. *Algebra* is univerſally known to be the very art and principle of *invention*; and in *arithmetick* too, we are frequently put upon the finding out of unknown numbers, by means of their relations and connections with others that are known.

The preſent method of notation is ſo contrived, as exactly to fall in with the form of numbering. For, as in the names of numbers, we riſe from *units* to *tens*, from *tens* to *hundreds*, from *hundreds* to *thouſands*, *&c.* ſo likewiſe in their notation, the ſame figures, in different places, ſignify theſe ſeveral combinations. Thus 2 in the firſt place on the right hand denotes two *units*, in the ſecond place it expreſſes ſo many *tens*, in the third *hundreds*, in the fourth *thouſands*. By this means it happens, that when a number is written down in figures, as every figure in it expreſſes ſome diſtinct combination, and all theſe combinations together make up the total ſum; ſo may the ſeveral figures be conſidered as the conſtituent parts of the number. Thus the number 2436 is evidently by the very notation diſtinguiſhed into four parts, mark'd by the four figures that ſerve to expreſs it. For the firſt denotes *two thouſand*, the ſecond *four hundred*, the third *thirty* or *three tens*, and the fourth *ſix*. Theſe ſeveral parts, tho' they here appear in a conjoined form, may yet be alſo expreſſed ſeparately thus, 2000, 400, 30 and 6, and the amount is exactly the ſame.

This being the caſe, if it is required to find a number, equal to the ſum of two others given; our buſineſs is, to examine ſeparately theſe given numbers. Let it be propoſed, to find a number, equal to the ſum of theſe two: 2436 and 4352. As the finding of this by a ſingle effort of thought, would be too violent an exerciſe for the mind; I conſider the figures repreſenting theſe numbers, as the parts of which they conſiſt, and therefore ſet myſelf to diſcover their ſums one after another. Thus 2 the firſt figure on the right hand of the one, added to 6 the firſt figure on the right hand of the other, makes 8, which is therefore the ſum of theſe two parts. Again, the ſum of 5 and 3, the two figures or parts in the ſecond place, is likewiſe 8. But now as figures in the ſecond place, denote not ſimple *units*, but *tens*; hence it is plain, that 5 and 3 here, ſignify five *tens* and three *tens*, or 50 and 30, whoſe ſum therefore muſt be eight *tens*, or 80. And here again I call to mind, that having already obtained one figure of the ſum, if I place that now found immediately after it, it will thereby ſtand alſo in the ſecond place, and ſo really expreſs, as it ought to do, eight *tens* or 80. And thus it is happily contrived, that tho' in the addition of *tens*, I conſider the figures compoſing

them as denoting only ſimple *units*, which makes the operation eaſier and leſs perplexed; yet by the place their ſum obtains in the number found, it expreſſes the real amount of the parts added, taken in their full and compleat values. The ſame thing happens in ſumming the *hundreds* and *thouſands*; that is, tho' the figures expreſſing theſe combinations, are added together as ſimple *units*; yet their ſums ſtanding in the third and fourth places of the number found, thereby really denote *hundreds* and *thouſands*, and ſo repreſent the true value of the parts added.

If now we turn our thoughts from *arithmetick* to *algebra*, here alſo we ſhall find, that the great art of invention lies, in ſo regulating and diſpoſing our notices of things, that we may be enabled to proceed gradually in the ſearch of truth. For it is the principal aim of this ſcience, by exhibiting the ſeveral relations of things in a kind of ſymbolical language, ſo to repreſent them, to the imagination, as that we may carry our attention from one to another, in any order we pleaſe. Hence, however, numerous thoſe relations are, yet by taking only ſuch a number of them into conſideration at once, as is ſuited to the reach and capacity of the underſtanding, we avoid perplexity and confuſion in our reſearches, and never put our faculties too much upon the ſtretch, ſo as to loſe ourſelves amidſt the multiplicity of our own thoughts. As therefore in *arithmetic*, we riſe to a juſt conception of the greateſt numbers, by conſidering them as made up of various progreſſive combinations; ſo likewiſe in *algebra*, thoſe manifold relations that often intervene, between known and unknown quantities, are clearly repreſented to the mind, by throwing them into a ſeries of diſtinct equations. And as the moſt difficult queſtions relating to numbers are managed with eaſe, becauſe we can take the parts or figures ſeparately, and proceed with them one after another; ſo alſo the moſt intricate problems of *algebra* are in like manner readily unfolded, by examining the ſeveral equations apart, and unravelling them according to certain eſtabliſh'd rules of operation.

Hence it appears, that the buſineſs of invention as practiſed in algebra, depends entirely upon the art of abridging our thoughts, reducing the number of particulars taken under conſideration at once to the feweſt poſſible, and eſtabliſhing that progreſſive method of inveſtigation; great advantages may redound to ſcience, by a happy notation or expreſſion of our thoughts. For, by this means we are enabled to repreſent the relations of things in the form of equations, and by variouſly proceeding with theſe equations, to trace out ſtep by ſtep, the ſeveral particulars we are in queſt of. As the amount of every ſtep of the inveſtigation lies fairly before us, by comparing them variouſly among themſelves, and adjuſting them one to another, we come at length to diſcern the reſult of the whole, and are enabled to form our ſeveral diſcoveries into an uniform and well-connected ſyſtem of truths, which is the great end and aim of all our enquiries.

Of the method of ſcience. There are three ſeveral ways of coming at the knowledge of truth. *Firſt*, by contemplating the ideas in our own minds. When we ſet ourſelves to conſider the ideas in our own minds, we variouſly compare them together, in order to judge of their agreement or diſagreement. Now as all the truths deduced in this way flow from certain connections and relations, diſcerned between the ideas themſelves; and as when the ſame ideas are brought into compariſon, the ſame relations muſt ever, and invariably ſubſiſt between them; hence it is plain, that the knowledge acquired by the contemplation of our ideas, is of a neceſſary and unchangeable nature. But farther, as theſe relations between our ideas, are not only ſuppoſed to be real in themſelves, but alſo to be ſeen and diſcerned by the mind; and as when we clearly perceive a connection or repugnance between any two ideas, we cannot avoid judging them to agree or diſagree accordingly; it evidently follows, that our knowledge of this kind is attended with abſolute certainty and conviction, inſomuch that as it is impoſſible for us to withhold our aſſent, or entertain any doubt as to the reality of truths ſo offered to the underſtanding. The relation of equality between the whole and all its parts, is apparent to every one, who has formed to himſelf a diſtinct notion of what the words *whole* and *part* ſtand for.

The ſecond way of coming at knowledge is by means of the ſenſes. From them we receive information of the exiſtence of objects without us, of the union and conjunction of different qualities in the ſame ſubject, and of the operations of bodies one upon another. Thus our eyes tell us, that there is in the univerſe ſuch a body as we call the ſun; our ſight and touch, that light and heat, or at leaſt the power of exciting thoſe perceptions in us, co-exiſt in that body; and laſtly, by the ſame ſight we alſo learn, that fire has the power of diſſolving metals, or of reducing wood to charcoal and aſhes. Whence note, the teſtimony of the ſenſes, tho' ſufficient to convince ſober and reaſonable men, yet does not ſo unavoidably extort our aſſent, as to leave no room for ſuſpicion or diſtruſt.

The third and laſt way of coming at truth is, by

by the *report* and *teſtimony* of others. This regards chiefly paſt facts and tranſactions, which having no longer any exiſtence, cannot be brought within the preſent ſphere of our obſervation, altho' this in many caſes is a ſufficient ground of aſſent, ſo as to produce a ready belief in the mind, yet it is liable to objections. Our ſenſes, on ſome occaſions deceive us, and therefore they may poſſibly on others. But this bare poſſibility creates little or no diſtruſt; becauſe there are fixed rules of judging, when they operate according to nature, and when they are perverted or given up to caprice. It is otherwiſe in matters of mere human teſtimony. For there, beſides the ſuppoſition that the perſons themſelves may have been deceived, there is a farther poſſibility, that they may have conſpired to impoſe upon others by a falſe relation. It would nevertheleſs be the height of folly, to reject all human teſtimony without diſtinction, becauſe of this bare poſſibility. Hence the facts of hiſtory, when well atteſted, are readily embraced by the mind; and tho' the evidence attending them be not ſuch, as produes a neceſſary and infallible aſſurance, it is yet abundantly ſufficient to juſtify our belief, and leave thoſe without excuſe, who upon the bare ground of poſſibility, are for rejecting entirely the conveyance of teſtimony.

Upon the whole then it appears, that *abſolute certainty*, ſuch as is attended with *unavoidable aſſent*, and excludes all poſſibility of being deceived, is to be found only in the contemplation of our own ideas. It is abſolutely impoſſible for a man to perſuade himſelf that that is not, which he plainly and neceſſarily perceives to be. And it is to knowledge attended with this laſt kind of evidence alone, that in ſtrictneſs and propriety of ſpeech, we attribute the name of *ſcience*. *Science* implies perception and diſcernment, what we ourſelves ſee and cannot avoid ſeeing, and therefore has place only in matters of abſolute certainty, where the truths advanced are either intuitive propoſitions, or deduced from them in a way of ſtrict demonſtration.

But here I expect it will be aſked, what kind of knowledge is it that we have relating to bodies, their powers, properties, and operations one upon another? To this I anſwer, that we have already diſtinguiſhed it by the name of *natural* or *experimental*. But that we may ſee more diſtinctly wherein the difference between *ſcientifical* and *natural* knowledge lies, it may not be improper to add the following obſervations. When we caſt our eyes towards the ſun, we immediately conclude, that there exiſts an object without us, correſponding to the idea in our minds.

Again, when a piece of gold is diſſolved in *aqua regia*, we ſee indeed and own the effect produced, but cannot be ſaid in ſtrictneſs and propriety of ſpeech, to have any perception or diſcernment of it. The reaſon is, becauſe being unacquainted with the intimate nature both of *aqua regia* and gold, we cannot from the ideas of them in our minds deduce, why the one muſt operate upon the other in that particular manner. Hence it is, that our knowledge of the facts and operations of nature, extends not with certainty beyond the preſent inſtance, or what falls under our immediate notice; ſo that in all our reſearches relating to them, we muſt ever proceed in the way of trial and experiment, there being here no general or univerſal truths, whereon to found *ſcientifical* deductions.

Experience is here the true and proper foundation of our judgments, nor can we by any other means arrive at a diſcovery, of the ſeveral powers and properties of bodies. How long might a man contemplate the nature of hemlock, examine the ſtructure of its parts in a microſcope, and torture and analyſe it by all the proceſſes of chymeſtry, before he could pronounce with certainty the effect it will have upon the human body? One ſingle experiment lays that open in an inſtant, which all the wit and invention of men would never of themſelves have been able to trace. The ſame holds in all the other parts of natural philoſophy. Our diſcoveries relating to electricity, the powers and properties of the load-ſtone, the force of gunpowder, *&c.* were not gained by reaſoning, or the conſideration of our abſtract ideas, but by means of experiments made with the bodies themſelves. Hence it happened, that while the philoſophy of *Ariſtotle* prevailed in the ſchools, which dealt much in metaphyſical notions, occult qualities, ſympathies, antipathies, and ſuch like words without meaning; the knowledge of nature was at a ſtand, becauſe men pretended to argue abſtractly about things, of which they had no perfect and adequate ideas, whereon to ground ſuch a method of reaſoning. But now in the preſent age, that we have returned to the way of trial and experiment, which is indeed the only true foundation of natural philoſophy, great advances have already been made, and the proſpect of ſtill greater lies before us.

Thus we may ſufficiently underſtand, wherein the proper difference lies, between *ſcientifical* and *natural* knowledge. In matters of *ſcience* we argue from the ideas in our own minds, and the connections and relations they have one to another. It is otherwiſe in the caſe of *natural* knowledge. Intuition and inward perception have here no place. We diſcern the powers and properties of thoſe objects

jects that ſurround us, merely by experience, and the impreſſions they make on the ſenſes.

It will naturally be aſked here, how come we by this aſſurance? I anſwer, not *ſcientifically*, and in the way of ſtrict *demonſtration*, but by *analogy*, and an *induction* of *experiments*. We diſtinguiſh fire, for inſtance, by ſuch of its qualities, as lie more immediately open to the notice of the ſenſes; among which light and heat are the moſt conſiderable. Examining ſtill farther into its nature, we find it likewiſe poſſeſſed of the power of diſſolving metals. But this new property, not having any neceſſary connection that we can trace, with thoſe other qualities by which fire is diſtinguiſhed, we cannot therefore argue with certainty, that wherever light and heat, *&c.* are, the power of diſſolving metals co-exiſts with them. 'Tis not till after we have tried the thing in a variety of experiments, and found it always to hold, that we begin to preſume there may be really ſome ſuch connection, tho' our views are too ſhort and imperfect to diſcover it. Hence we are led to frame a general concluſion, arguing from what has already happened, to what will happen again in the like caſes; inſomuch that where we meet with all the other properties of fire, in any body, we have not the leaſt doubt, but that upon trial, the power above-mentioned will be found to belong to it alſo. This is called reaſoning by *analogy*; and it is, as we ſee, founded entirely upon induction, and experiments made with particular objects.

Having aſcertained the general properties of things by *analogy*, if we proceed next to eſtabliſh theſe as *poſtulata* in philoſophy, we can upon this foundation build ſtrict and *mathematical* demonſtrations, and thereby introduce *ſcientifical* reaſoning into *natural* knowledge. In this manner Sir *Iſaac Newton*, having determined the laws of gravity by a variety of experiments, and laying it down as a principle that it operates according to thoſe laws thro' the whole ſyſtem of nature; has hence in a way of ſtrict demonſtration, deduced the whole theory in the heavenly motions. For granting once this *poſtulatum*, that gravity belongs univerſally to all bodies, and that it acts according to that ſolid content, decreaſing with the diſtance in a given ratio; what Sir *Iſaac* has determined in regard to the planetary motions, follows from the bare conſideration of our own ideas; that is, neceſſarily and *ſcientifically*. Thus likewiſe in *opticks*, if we lay it down as a principle, that light is propagated on all ſides in right lines, and that the rays of it are reflected and refracted, according to certain fixed invariable laws, all which is known to be true by experience; we can, upon this foundation, eſtabliſh mathematically the theory of viſion. The ſame happens in *mechanicks*, *hydroſtaticks*, *pneumaticks*, &c. where from *poſtulata* aſcertained by experience, the whole theory relating to theſe branches of knowledge, follows in a way of ſtrict demonſtration.

If abſolute and infallible certainty is not to be obtained in *natural* knowledge, much leſs can we expect it in *hiſtorical*. For here teſtimony is the only ground of aſſent, and therefore the poſſibility of our being deceived, is ſtill greater than in the caſe of experience. There is however a way of reaſoning even here, that begets an entire acquieſcence, and leads us to embrace without wavering, the facts and reports of hiſtory. If for inſtance it appears, that the hiſtorian was a man of veracity; if he was a competent judge of what he relates; if he had ſufficient opportunities of being informed; if the book that bears his name was really writ by him; if it has been handed down to us uncorrupted; in fine, if what he relates is probable in itſelf, falls in naturally with the other events of that age, and is atteſted by contemporary writers. By theſe and ſuch like arguments, founded partly on criticiſm, partly on probable conjecture, we judge of paſt tranſactions; and though they are not capable of *ſcientifical* proof, yet in many caſes we arrive at an undoubted aſſurance of them. For as it is abſurd to demand mathematical demonſtration in matters of fact, becauſe they admit not of that kind of evidence; it is no leſs ſo to doubt of their reality, when they are proved by the beſt arguments their nature and quality will bear.

But here perhaps it will be aſked: Where is the advantage of barely contemplating our ideas, and tracing their ſeveral habitudes and relations, when it is in truth the reality of things that we are chiefly concerned to know, and thoſe reſpects they bear to us and one another? To this I anſwer: that if indeed our ideas no way regarded things themſelves, the knowledge acquired by their means would be of very little conſequence to human life. But ſince, as we have already obſerved, whatever is true in idea, is unavoidably ſo alſo in the reality of things, where things exiſt anſwerable to theſe ideas; it is apparent, that by copying our ideas with care from the real objects of nature, and framing them in a conformity to thoſe conjunctures and circumſtances in which we are moſt likely to be concerned, a way is laid open to diſcoveries of the greateſt importance to mankind. For in this caſe, our ſeveral reaſonings and concluſions, holding no leſs of the objects themſelves, than of the ideas by which they are repreſented, may be therefore applied with certainty to theſe objects, as often as they fall under our notice. It is not therefore enough that we ſet about the conſideration of any

ideas at random; we muſt farther take care that thoſe ideas truly regard things themſelves.

It now remains that we lay down the rules of method peculiar to this branch of knowledge, and give ſome account of the manner, in which that certainty and conviction which are inſeparable from it, may be moſt naturally and effectually produced. *Science*, as we have ſaid, regards wholly the abſtract ideas of the mind, and the relations they have one to another. The great ſecret therefore of attaining it lies, in ſo managing and conducting our thoughts, as that theſe ſeveral relations may be laid open to the view of the underſtanding, and become the neceſſary and unavoidable objects of our perception. In order to this we muſt make it our firſt care, diſtinctly to frame and ſettle the ideas, about which our enquiries are to be employed. For though the multitude of parts, in many caſes, be great, I may ſay beyond belief; yet as they have been all previouſly formed into ſeparate claſſes, and the claſſes themſelves diſtinctly ſettled in the underſtanding; we find it eaſy by ſuch a ſeries of ſteps, to riſe to any idea how complex ſoever, and with a ſingle glance of thought embrace it in its full extent.

But it is not enough that we barely form ideas in our own minds: we muſt alſo contrive a way to render them ſtable and permanent, that when they diſappear upon calling off our attention, we may know how to retrieve them again with certainty. This is beſt done by words and deſcriptions, which ſerve not only to ſubject them to our own review, but alſo to lay them open to the perception of others.

Thus we ſee, that the *method of ſcience* begins with unfolding our ideas, and communicating them by means of definitions. And here it is of great importance to obſerve, that there muſt be in all languages, certain original and elementary names, whence our deſcriptions take their firſt riſe, and beyond which we cannot trace the meaning and ſignification of ſounds.

When, therefore, in the *method of ſcience*, we have finiſhed the buſineſs of *definitions*; it muſt be our next care, diſtinctly to unfold in *propoſitions*, thoſe immediate and intuitive *relations*, which are neceſſarily ſeen and owned by the mind, upon the very firſt comparing of our ideas one with another. Theſe propoſitions have obtained the name of *firſt principles*, becauſe occuring *firſt* in the order of knowledge, and being manifeſt of themſelves, they ſuppoſe not any *prior* truths in the mind, whence they may be evidenced and explained. The nature of theſe propoſitions is explained in the ſecond part, the notion of ſelf-evidence is unfolded, and the manner of diſtinguiſhing between the truths of this claſs, and thoſe that are demonſtrable is there taught alſo. Thus we are gradually led from ſimple ideas, through all the windings and labyrinths of truth, until we at length reach the higheſt and moſt exalted diſcoveries of human reaſon.

MAGICK.

MAGIC, taken in its antient ſenſe, is the ſcience or diſcipline and doctrine of the *magi*, or wiſe-men of *Perſia*. — And taken in a more modern ſenſe, is a ſcience, which teaches to perform wonderful and ſurprizing effects.

Agrippa divides *magic* into three kinds, *natural*, *celeſtial*, and *ceremonial* or *ſuperſtitious*.

Natural magick is no more than the application of natural active cauſes to paſſive cauſes, or ſubjects, by means whereof many ſurprizing, but yet natural effects are produced; as producing roſes, figs, &c. in *March*, cauſing thunder, lightning, rains, winds, &c.

Baptiſta Porta has a treatiſe of *natural magic*, or of ſecrets for performing very extraordinary things by natural cauſes.

The *natural magick* of the *Chaldeans* was nothing but the knowledge of the powers of ſimples and minerals. The *magick*, which they called *theurgia*, conſiſted wholly in the knowledge of the ceremonies, to be obſerved in the worſhip of the gods, in order to be acceptable. By virtue of thoſe ceremonies they believed they could converſe with ſpiritual beings, and cure diſeaſes.

Celeſtial magick borders nearly on judiciary aſtrology; it attributes to ſpirits a kind of rule or dominion over the planets, and to the planets a dominion over men; and on thoſe principles build a ridiculous kind of ſyſtem.

Superſtitious or *goetick magick* conſiſts in the invocation of the devil; its effects are uſually evil and wicked, though very ſtrange, and ſeemingly ſurpaſſing the power of nature, ſuppoſed to be produced by virtue of ſome compact, either tacit or expreſs, with evil ſpirits: but the truth is, theſe have not all the power that is uſually imagined, nor do they produce half thoſe effects ordinarily aſcribed to them. *Paracelſus* tells us, that pronouncing the words *oſy oſya*, will make ſerpents

ſtop

ſtop their motion, and lie ſtill as if they were dead.

Naude publiſhed an apology for all the great men ſuſpected of *magick*. — *Agrippa* ſays, that the words uſed by thoſe in compact with the devil, to invoke him, and to ſucceed in what they undertake, are *dies, mies, jeſquet, benedaſet, decevima, enitemaus*. There are an hundred other formulas of words, compoſed at pleaſure, or gathered from different languages, or patched in imitation of it.

The origin of *magick*, according to our firſt definition, is aſcribed to *Zoroaſter: Salmaſius* derives the very name from *Zoroaſter*, who, he ſays, was ſurnamed *Mag*, whence *Magus*. — Others, make him only the reſtorer and improver of the *Perſian* philoſophy; alledging that many of the *Perſian* rites, in uſe among the *Magi*, were borrowed from the *Jabii* among the *Chaldeans*, who agreed in many things with the *Magi* of the *Perſians*; whence ſome make the name *magus* common both among the *Chaldeans* and *Perſians*. Thus *Plutarch* mentions, that *Zoroaſter* inſtituted *magi* among the *Chaldeans*, in imitation whereof the *Perſians* had theirs too.

The philoſophy principally cultivated among them was theology and politicks; they being always eſteemed as the interpreters of all laws both divine and human, on which account they were wonderfully revered by the people. Hence *Cicero* obſerves, that none were admitted to the crown of *Perſia*, but ſuch as were well inſtructed in the diſcipline of the *Magi*, who taught τα βασιλικα and ſhewed princes how to govern.

Plato, Apuleius, Laertius, and others agree, that the philoſophy of the *Magi* related principally to the worſhip of the Gods: they were the perſons, who were to offer prayers, ſupplications, and ſacrifices, as if the Gods would be heard by them alone.

According to *Lucian, Suidas*, &c. the theology, or worſhip of the Gods, about which the *Magi* were employed, was little more than the diabolical art of divination. So that μαγικα ſtrictly taken, ſignifies divination.

Philo-Judæus deſcribes the *Magi* to be diligent enquirers into nature, out of the love they bear to truth; and who ſetting themſelves a-part for thoſe things, contemplate the divine virtues the more clearly, and initiate others in the ſame myſteries.

Their deſcendants, the modern *Magi*, or fire-worſhippers, are divided into three claſſes; whereof the firſt and moſt learned, neither eat nor kill animals, but adhere to the old inſtitution of abſtaining from living creatures. —The *Magi* of the ſecond claſs, refrain only from tame animals; nor do the laſt kill all indifferently; it being the firm and diſtinguiſhing dogma of them all, that *there is a tranſmigration of ſoul*. To imitate the ſimilitude between animals and men, they call the latter by the name of the former; thus their fellow-prieſts they called lions; the prieſteſſes, lioneſſes; the ſervants, crows, *&c.*

Magic, according to our other definition, is only uſed to ſignify an unlawful and diabolical kind of ſcience, particularly the *ſuperſtitious* and *goetic magick* depending on the aſſiſtance of the devil and departed ſouls.

Under this we include *oracles*. ORACLE, was an anſwer uſually couched in very dark and ambiguous terms, ſuppoſed to be given by Dæmons, either by the mouths of their idols, or by thoſe of their prieſts to the people, who conſulted them on things to come.

M. *Bayle* ſays poſitively, they were meer human artifices, which the devil had no hand in. He is ſtrongly backed by *Van Dale* and M. *Fontenelle*, who have wrote expreſly on the ſubject.

F. *Balſhus*, a learned Jeſuit, labours to prove that there were real *oracles*, and ſuch as can never be attributed to any artifices of the prieſts or prieſteſſes; ſeveral of theſe became ſilent in the firſt ages of the church, either by the coming of *Jeſus Chriſt*, or by the prayers of the ſaints.

It was *Euſebius*, who firſt endeavour'd to perſuade the Chriſtians, that the coming of *Jeſus Chriſt* had ſtruck the oracles dumb; though it appears from the laws of *Theodoſius, Gratian*, and *Valentinian*, that the *oracles* were ſtill conſulted as low as the year 385. *Cicero* ſays, the *oracles* became dumb in proportion as people growing leſs credulous, began to ſuſpect them for cheats.

Moſt of the fathers of the church took it to be the devil that gave *oracles*; and looked on it as a pleaſure he took to give dubious and equivocal anſwers; in order to have a handle to laugh at them. *Voſſius* allows, that it was the devil who ſpoke in *oracles*, but thinks that the obſcurity of his anſwer was owing to his ignorance, as to the preciſe circumſtances of the events. That artful and ſtudied obſcurity, wherein the anſwers were couched, ſhewed the embarraſs the devil was under; as thoſe double meanings they uſually bore provided for their accompliſhment.

For my part I am of M. *Fontenelle*'s opinion, that the *oracles* were nothing but meer cheats, frauds, and impoſtures of the *Pagan* clergy, to impoſe on the too great credulity of mankind, gain a certain reſpect and veneration from them, pick their pockets, and render themſelves abſolutely neceſſary. For, to believe that it was the devil, who uſed to ſpeak in the idols, is to arraign the veracity of the true God, who ſays poſitively, that *he wills*

that

that all men ſhould be ſaved. If it be objected to this, that God ſuffered only the devil to ſpeak in the idols, and that he is not obliged to undeceive us, if we will deceive ourſelves; I'll anſwer, that the devil ſpeaking in the idols, and giving *oracles*, could not be a ſingle tolerance; ſince the devil being a pure ſpiritual intelligence, the nature thereof is only to form ideas, without being capable to inveſt them with words, ſince they have no organs to articulate them; God muſt have operated a miracle every time an oracle was pronounced, and therefore poſitively contributed towards deceiving mankind, and thereby rendered their reprobation of an abſolute, or indiſpenſible neceſſity, which none can ſuppoſe without impiety.

Oracle, is alſo uſed for the Dæmon who gave the anſwer, and the place where it was given.

The principal *oracles* of antiquity, were that of *Abæ*, mentioned by *Herodotus*; of *Amphiareus*; of the *Branchidæ* at *Didimus*; of the *Camps* at *Lacedæmon*; of *Dodona*; of *Jupiter Ammon*; of *Nabarca*, in the country of *Andriaca*, near the *Caſpian Sea*; of *Trophonius*, mentioned by *Herodotus*; of *Chryſopolis*; of *Clares* in *Ionia*; of *Mallos*; of *Patarea*; of *Pela* in *Macedonia*; of *Phaſelides* in *Cilicia*; of *Sinope* in *Paphlagonia*; of *Orpheus*'s *Head*, mentioned by *Philoſtratus* in his life of *Apollonius*, &c.

But of all others, the *oracle* of *Apollo Pythius* at *Delphos*, was the moſt celebrated; this was conſulted in the *dernier reſort*, by moſt of the princes of thoſe ages.

The *Pythia*, which was to be a pure virgin, was always in a rage when ſhe gave *oracles*; at firſt ſhe gave them in verſe, and fell at length to proſe, upon the people's beginning to laugh at the poorneſs of her verſification.

MATHEMATICKS.

MATHEMATICKS (from μαθησις, which ſignifies *diſcipline* or *ſcience*) is the ſcience of quantity, or a ſcience that conſiders magnitudes, either as computable or meaſurable.

Mathematicks are divided with regard to their end, into *ſpeculative* and *practical*.

Speculative mathematicks are thoſe, which reſt in the bare contemplation of the properties of things.

Practical mathematicks are thoſe, which apply the knowledge of thoſe properties to ſome uſes in life.

With regard to their object, *mathematicks* are divided into *pure* or *abſtract*, and *mix'd*.

Pure mathematicks conſider quantities abſtractedly; without any relation to matter or bodies.

Mix'd mathematicks conſider quantity as ſubſiſting in material beings, *e. gr.* length in a road, breadth in a river, height in a ſtar, *&c.*

Pure mathematicks again, either conſider quantity as diſcrete, and ſo computable, as *arithmetick*; or as concrete, or continued, and ſo meaſurable, as *geometry*, and *trigonometry*.

Mix'd mathematicks are very extenſive, and are diſtinguiſhed by various names, as the ſubjects they conſider, and the views, wherein they take them, vary; it being ſufficient to determine an art to be a branch of *mix'd mathematicks*, that *pure mathematicks* are applicable thereto, *i. e.* that it may be explained and demonſtrated from the principles of arithmetick and geometry. Such are

Mechanicks, which conſider motion, or the law of moving bodies.—*Hydroſtaticks*, which conſider the laws of fluids, or of bodies gravitating in fluids.—*Pneumaticks*, the air, with regard to the laws of menſuration thereof.—*Hydraulicks*, the motion of fluids.—*Opticks* direct light or viſion.—*Catoptricks*, reflected viſion.—*Dioptricks*, refracted viſion.—*Perſpective*, the images of objects, in order to delineate or repreſent them.—*Aſtronomy*, the univerſe and the phænomena of the heavens.—*Geography*, the earth, both as in itſelf, and in its affections.—*Hydography*, the ſea, principally as navigable.—*Chronology*, time, with regard to the meaſuring and diſtinguiſhing thereof.—*Gnomonicks*, or *Dialling*, ſhadows, in order for determining the hour of the day.—*Pyrotechny*, artificial fires, with regard both to diverſion, and to the uſes of war.—*Military Architecture*, the ſtrength of places, with regard to their defence againſt an enemy.—*Civil Architecture* (now become a branch of *Mathematicks*) buildings.—*Muſick*, ſounds, and their effects on the ear. All which are treated of under their particular heads.

For the origin of the *Mathematicks*, *Joſephus* dates it before the flood, and makes the ſons of *Seth* obſervers of the courſe and order of the heavenly bodies.

The firſt who cultivated *mathematicks* after the flood, were the *Aſſyrians* and *Chaldeans*; from whom the ſame *Joſephus* adds, they were carried by *Abraham* to the *Egyptians*; who proved ſuch notable proficients, that *Ariſtotle* makes no ſcruple to fix the firſt riſe of *mathematicks* among them. From *Egypt*, 584 years before Chriſt, they paſſed

into *Greece* through the hands of *Thales*, who having learnt Geometry of the *Egyptian* prieſts, taught it in his own country. After *Thales* comes *Pythagoras*, who among other mathematical arts, paid a peculiar regard to Arithmetick, fetching the greateſt part of his philoſophy from numbers: he was the firſt, as *Laertius* tells us, who abſtracted geometry from matter, and to him we owe the doctrine of incommenſurable magnitude, and the five regular bodies, beſides the firſt principles of muſick and aſtronomy. *Pythagoras* was ſucceeded by *Anaxagoras*, *Euripides*, *Briſo*, *Antipho*, and *Hippocrates* of *Scio*; who all applied themſelves particularly to the quadrature of the circle, the duplicature of the cube, *&c.* but the laſt with moſt ſucceſs: this laſt is alſo mentioned by *Proclus*, as the firſt who compiled elements of *mathematicks*.

Democritus excelled in *mathematicks* as well as phyſicks, though none of his works in either kind are extant. The next in order is *Plato*, who not only improved *geometry*, but introduced it into *phyſicks*, and ſo laid the foundation of a ſolid philoſophy. Out of his ſchool proceeded a crowd of *mathematicians*; *Proclus* mentions thirteen of note; among whom was *Leodamus*, who improved the analyſis firſt invented by *Plato*; *Theætetus*, who wrote elements; and *Archytas*, who has the credit of being the firſt who applied *mathematicks* to uſe in life. Theſe were ſucceeded by *Neocles* and *Theon*, the laſt of whom contributed to the elements. *Eudoxus* excelled in Arithmetick and Geometry, and was the firſt founder of a ſyſtem of Aſtronomy. *Menechmus* invented the conick ſections; and *Theudrus* and *Hermitomus* improved the elements.

As for *Ariſtotle*, his works are ſo ſtored with *mathematicks*, that *Blancanus* compiled a whole book of them: out of his ſchool came *Eudemus* and *Theophraſtus*; the firſt of whom wrote of numbers, geometry, and inviſible lines; the latter a mathematical hiſtory. To *Ariſteus*, *Iſidorus*, and *Hypſicles*, we owe the books of ſolids, which, with the other books of elements, were improved, collected, and methodized by *Euclid*, who died 284 years before Chriſt.

An hundred years after *Euclid*, came *Eratoſthenes* and *Archimedes*. Contemporary with the latter was *Conon*, a geometrician and aſtronomer. Soon after came *Apollonius Pergæus*; whoſe conicks are ſtill extant. To him are likewiſe aſcribed the fourteenth and fifteenth books of *Euclid*, which are ſaid to have been contracted by *Hypſicles*. *Hipparchus* and *Menelaus*, wrote on the ſubtences in a circle; the latter alſo on ſpherical triangles: *Theodoſius*'s three books of ſphericks are ſtill extant; and all theſe, *Menelaus* excepted, lived before Chriſt.

In the year 70, of Chriſt, *Ptolemy* of *Alexandria* was born, the prince of aſtronomers, and no mean geometrician; he was ſucceeded by the philoſopher *Plutarch*, of whom we have ſtill extant ſome mathematical problems. After him came *Eutocius*, who commented on *Archimedes*; and occaſionally mentions the inventions of *Philo*, *Diocles*, *Nicomedes*, *Sporus*, and *Heron*, on the duplicature of the cube. To *Cteſebes* of *Alexandria* we owe our pumps; and *Geminus*, who came ſoon after, is preferred by *Proclus* to *Euclid* himſelf.

Diophantus of *Alexandria* was a great maſter of numbers, and the firſt inventor of *Algebra*; among others of the antients, *Nichomacus* is celebrated for his arithmetical, geometrical, and muſical works; *Serenus* for his book on the ſection of the cylinder; *Proclus* for his comments on *Euclid*; and *Theon* has the credit among ſome of being author of the books of elements aſcribed to *Euclid*. The laſt to be named among the antients, is *Pappus* of *Alexandria*, who flouriſhed in the year of Chriſt 400, and is celebrated for his books of mathematical collections ſtill extant.

MECHANICKS.

MECHANICKS are conſidered under the mixed *mathematical ſcience*, which conſiders motion or moving powers, their nature and laws, with the effects thereof, in machines, *&c.*

That part of *mechanicks*, which conſiders the motion of bodies ariſing from gravity, is by ſome called *ſtaticks*; in diſtinction from that part, which conſiders the mechanical powers, and the application properly called *mechanicks*. So that on this footing *ſtaticks* ſhould be the doctrine or theory of motion; and *mechanicks* the application thereof. But as the whole doctrine of *mechaniſm* depends entirely on a ſole point, which is to find the *center of gravity* of bodies: I'll begin this treatiſe by examining what is gravity, with reſpect to *mechanicks*; how gravity is divided; the center of gravity, *&c.*

DEFI-

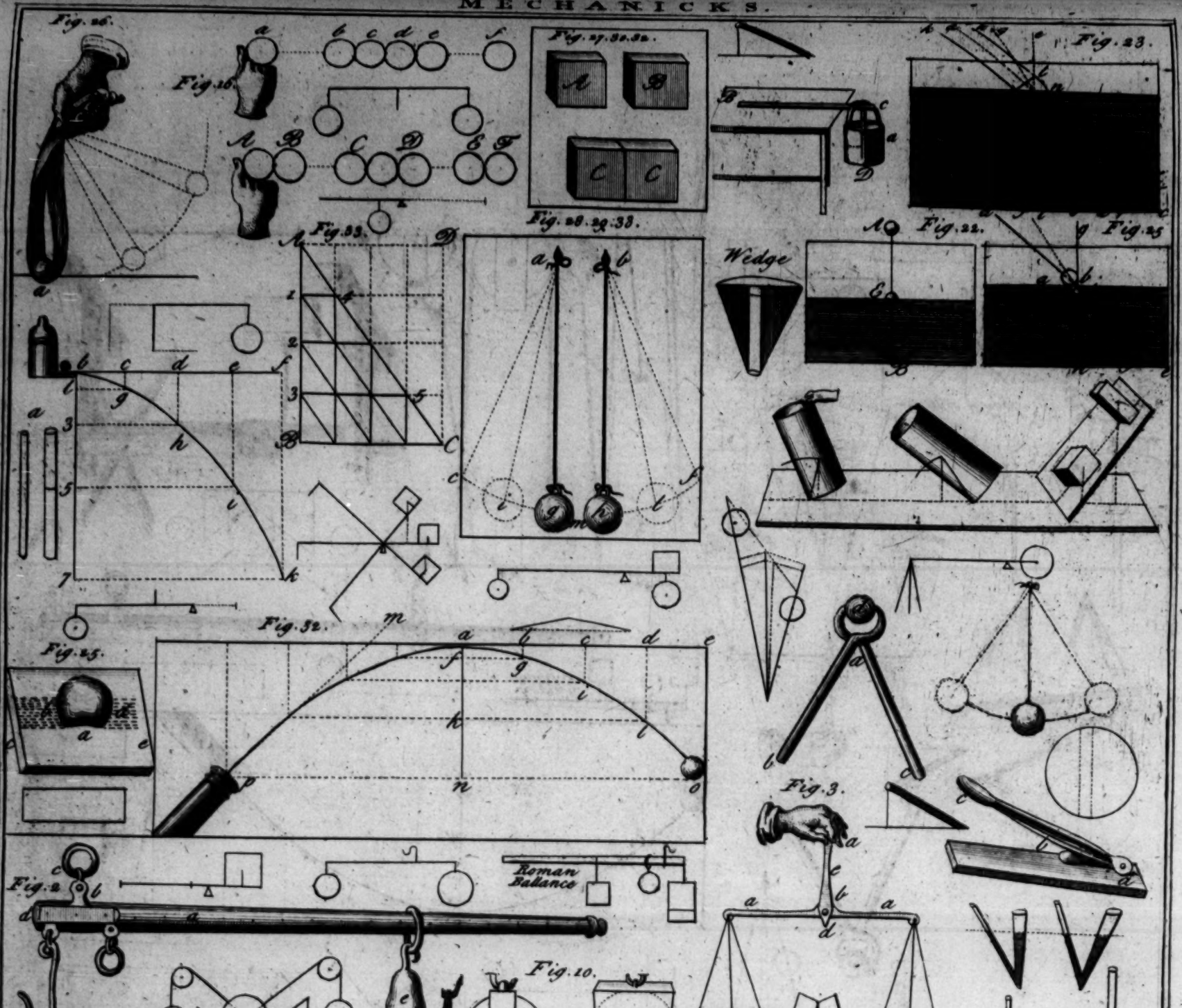
Fig. 26.
Fig. 16.
Fig. 27. 31. 32.
Fig. 23.
Fig. 28. 29. 38.
Fig. 33.
Wedge
Fig. 22.
Fig. 25
Fig. 32.
Fig. 25.
Fig. 3.
Fig. 2
Roman Ballance
Fig. 10.

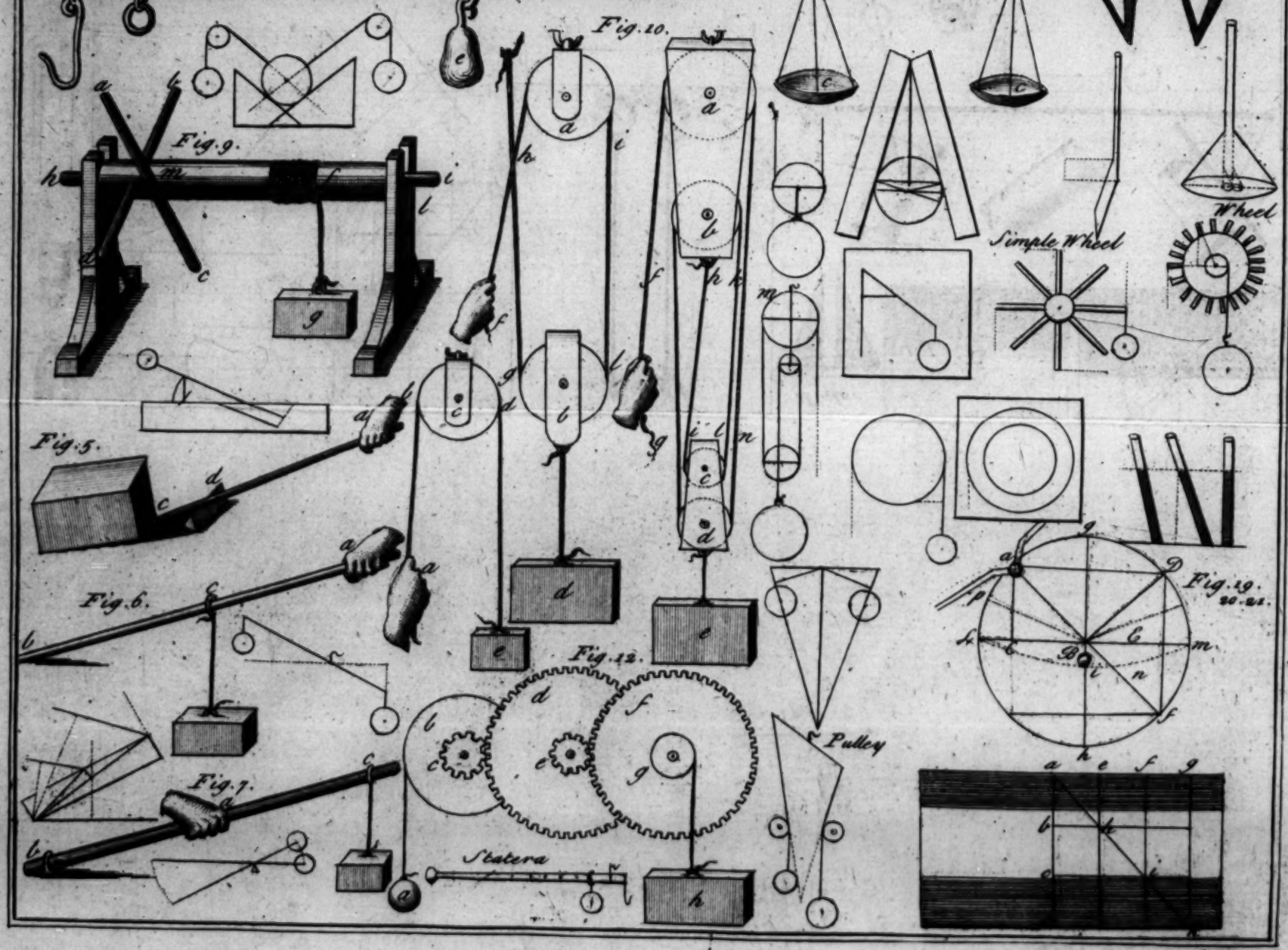
Fig. 9.
Fig. 10.
Simple Wheel
Wheel
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 12.
Fig. 19. 20. 21.
Pulley
Statera

DEFINITIONS.

Gravity, in *mechanicks*, denotes the tendency of bodies towards the center of the earth: and it is diſtinguiſhed into *abſolute* and *relative*.

Abſolute gravity is that, whereby a body deſcends freely through an unreſiſting medium; as a ſtone in the air, which in its deſcent only touches the æthereal particles.

Relative gravity is that, wherewith a body deſcends, after it has ſpent part of its weight in overcoming ſome reſiſtance. Such is that, wherewith a body deſcends along an inclined plane, where ſome part is employed in overcoming the reſiſtance or friction of the plane.

The *center of magnitude* of a body is a point as equally diſtant, as poſſible, from the two extreams.

The *center of motion* of a body is the fixed point, round which one or more heavy bodies, that have one common center of gravity, revolve.

The *center of gravity* is a point within a body, through which, if a plane, paſs the ſegments on each ſide will be equal and equiponderate, *i. e.* neither of them can move the other.

Whatever moves, or ſuſpends a body, is called a *moving power* or *faculty*.

The quantity of power is determined from the quantity of gravity of the power ſuſpended or moved, *v. g.* if the body A be carried downward, according to the line B C, *Fig.* 1. by a power of 10 pounds weight, the power, which ſtops its deſcent, whether it only ſuſpends it, or forces or draws it from C towards B, will be called a power of 10 pounds.

Whatever can accelerate, or ſtop the motion of a body, is called *machine*.

There are two ſorts of *machines*, ſome *ſimple* and others *compound*.

Simple machines are thoſe otherwiſe called *mechanical powers*.

There are ſix *ſimple machines*, to which all others may be reduced, *viz.* the *ballance*, *lever*, *wheel*, *pully*, *wedge*, and *ſcrew*; to which may be added the *inclin'd plane*, ſince it is certain that the moſt heavy bodies are lifted up by its means, which otherwiſe could not be moved.

Compound machine is that which is compoſed of ſeveral ſimple ones combined together.

The *application of the weight* or *power* to the lever, is the angle of the line of direction of that power or weight with the lever.

The *diſtance of power* or *weight* is the ſpace from the point of the machine, to which the power or weight is applied, to the center of the motion.

The *ballance* or *balance*, is uſed principally for determining the quality or difference of weights in heavy bodies, and conſequently their maſſes or quantities of matter.

The *ballance* is of two kinds,

1. The *antient* or *Roman*, called alſo *ſtatera Romana*, conſiſts of a lever, *a*, *Fig.* 2. or a beam, moveable on a center *b*, and ſuſpended near one of its extremes *c*; on one ſide the center *d*, are applied the bodies to be weighed, and their weight is meaſured by the diviſion marked on the beam; on the other ſide is the place where a weight moveable *e*, along it keeps the *ballance* in equilibrium.

2. The *modern ballance*, *Fig.* 3. now ordinarily in uſe, conſiſts of a lever or beam *a*, ſuſpended exactly by the middle *b*, to the extreams whereof are hung ſcales or baſons, *c c*.

In each caſe the beam is called the *jugum*, and the two moieties thereof on each ſide the axis, the *arms*: and the handle whereby it is held *trutina*. The line on which the beam turns, or which divides its *arms* is called the axis *d*, and when conſidered to the length of the *arms*, is eſteemed but a point, and called the *center of the ballance*; and the places where the weights are applied, the *points of ſuſpenſion* or *application*. That ſlender part perpendicular to the *jugum*, whereby either the equilibrium, or preponderancy of bodies is indicated, is called the *tongue of the ballance*, *e*.

In the *Roman ballance*, therefore, the weight uſed for a counter-ballance is the ſame, but the points of application various. In the common *ballance*, the counterpoiſe is various, and the point of application the ſame.

The principle on which each is founded is the ſame, and may be conceived from what follows.

The beam, *a a*, *Fig.* 3. which is the principal part of the *ballance*, is a lever of the firſt kind, which (inſtead of reſting on a *fulcrum* at *d*, its center of motion) is ſuſpended by ſomewhat faſten'd to *d*, its center of motion.

Hence as the known weight is to the unknown, ſo is the diſtance of the unknown weight from the center of motion, to the diſtance of the known weight, where the two weights will counter-poiſe to each other; conſequently the known weight ſhews the quality of the unknown.

To the *juſtneſs of a ballance* it is required, that the points of ſuſpenſion be exactly in the ſame line as the center of the *ballance*; that they be preciſely equidiſtant from that point on either ſide; that the *brachia* or *arms* be as long as conveniently they may, that there be as little friction as poſſible in the motion of the beam and ſcales, and laſtly, that the center of gravity of the beam be placed a little below the center of the motion.

A Lever is an inflexible right line, ſupported in a ſingle point, on a fulcrum or prop, and uſed for the raiſing of weights; being either void of weight itſelf, or at leaſt having ſuch a weight as may be commodiouſly counter-balanced.

In a *lever* there are three things conſidered; the *weight* to be *raiſed* or *ſuſtained*, the *power*, by which it is *raiſed* or *ſuſtained*, and the *fulcrum* or *prop*, whereon the *lever* is ſuſtained, or rather on which it moves round, the fulcrum remaining fix'd.

Levers are of three kinds; ſometimes the *fulcrum b* is placed between the weight *a* and the power *c*, *Fig.* 5. this we call a *lever of the firſt kind.* Sometimes the weight *c* is between the *fulcrum b*, and the power *a*; which is called a *lever of the ſecond kind*, as in *Fig.* 6. And ſometimes the power acts between the weight and the fulcrum *b*, *Fig.* 7. which is the *lever of the third kind.*

In the firſt kind of levers, *Fig.* 5. ſo much as the diſtance *a b* ſurpaſſes the diſtance *c b*, as much the power *a* ſurpaſſes the weight *c*. Therefore if the ſpace *a b*, which is between the power *a*, and the point fix'd *b* is ten times longer than the ſpace *c b*, which is between the fulcrum *b* and the weight *c*, and that weight *c* be conſidered as a hundred pounds weight, provided the power *a* be equivalent to ten pounds and a little more, it will ſurpaſs the weight *c* and raiſe it, provided that when the power *a* ſhall deſcend by ten ounces or inches, and a little more, the point *c* be riſen of an ounce or an inch breadth only, becauſe whatever increaſe the power acquires, proceeds either from the greater ſpace or velocity, or from the length of time.

The ſame muſt be ſaid of the ſecond kind of *lever*, becauſe as the more the diſtance *a b*, *Fig.* 6. ſurpaſſes the diſtance *c b*, the more efficaciouſly and eaſily the power *a* ſurpaſſes the weight *c*.

The third kind of *levers* do not render the power *a*, *Fig.* 7. more efficacious; but rather increaſe the weight *c*, and adds ſtrength to it, becauſe the diſtance of the power *a* from the point fix'd *b*, is leſſer than the diſtance of the weight *c*, from the ſame point fix'd *b*; but in that caſe the power muſt run through leſs ſpace than the weight.

It appears by the ſole inſpection that the *Roman ſtatera* is a *lever* of the firſt kind; for in the *forceps*, *a b c d*, *Fig.* 3. there are two *levers* of the firſt kind, which have but one hypomachlion, *viz.* in the point *a*, round which each arm of the *forceps* is turned; and the leſſer is the diſtance *a d*, than either *a b* or *a c*, the better the power applied in *b* and *c*, counter-balance the body placed in *d*.

A knife placed by one of its ſides in the point *a*, *Fig.* 6. ſo that it may incline towards that point, ſhews the ſecond kind of *lever*; in which, if the power be applied in *c*, and a piece of bread, or ſome other thing like it, be placed in *b*, the more the power will be diſtant from the point fixt *a*, the ſtronger the power will act.

Thus when we uſe a *lever* of the firſt kind, the power can be greater or leſſer than the weight, according as the diſtance of the weight is greater or leſſer than that of the power.

When we uſe a *lever* of the ſecond kind, the diſtance of the weight is neceſſarily leſſer than the diſtance of the power, as the power is neceſſarily leſſer than the weight.

On the contrary, when we make uſe of a *lever* of the third kind, the diſtance of the weight is neceſſarily greater than the diſtance of the powers, as the power is neceſſarily greater than the weight.

Axis in peritochio, is a machine or *mechanical* inſtrument proper, in which the cylinder *b i*, Fig. 9. called the *axis*, is ſuſtained at both ends by the fulcrums *k l*, with the circle in *c*, called the *peritochium*, in the circumference whereof are made holes, to which are fitted the ſpokes, or *radii*, *a m c*, *b m d*, to which the force being applied, it winds up a rope round the axis, whereby the weight, *&c.* is to be raiſed.

The *axis in peritochio*, takes place in the motion of every machine, where a circle may be conceived deſcribed about a fixed *axis*, concentrick to the plane of a cylinder, about which it is placed, as in crane-wheels, mill-wheels, capſtons, *&c.*

Nothing more eaſy than to ſhew that the *axis in peritochio*, as we repreſent it here, is to be referred to the *lever* of the firſt kind. For the point fixt is in the middle of the circle and axis, *viz.* in the point *a f*. For when the cylinder is turned round, innumerable fixt points can be conceived in it from the extreme *h* to *i*, or rather in lieu of points ſixt, is to be conceived a middle fixt and immoveable line from *h* into *i*, round which the cylinder is turned. The power is in *a* or in *b*, *&c.* and recedes from the point fixt, or the middle immobile line, not only the whole ſemi-diameter of the axis and the circle, but beſides of the whole length of the ſpoke *a m* or *b m*, &c. the weight placed in the point of the ſuperficy, *e*, and is removed of the ſcle ſemi-diameter *c f*, from the point fix'd *f*. Whence the more the diſtance *a m* ſurpaſſes the diſtance *e f*, the eaſier the power applied in *a* ſurpaſſes the weight, which is underſtood to be placed in *e*; and the greater the radius, the more increaſe will the power acquire.

But if a periphery be put round the extremes *a b c* to make an entire wheel, which ſeveral men could turn round, it would be nothing more but continued. The ſame muſt be ſaid of thoſe large wheels, which men, ſhut up in them, turn round with their feet, to draw up by means of a cable,

immenſe

immenſe weights, *viz.* either ſtones from quarries, or beams at the top of houſes, *&c.*

The *pulley*, *Fig.* 10. is a machine conſiſting of a little wheel or rundle, having a channel round it, and turning on an axis, ſerving by means of a rope which ſlides in its channel, for the raiſing of weights.

If the *pulley* be ſimple, *i. e.* if it has but one wheel or rundle (for ſome of them have ſeveral rundles) which rundle turns round an immobile axis, ſuch a pulley does not increaſe the power; for the motion of the weight *e* is equal to that of the power *a*, and the aſcent of *e* equal to the deſcent of *a*. Whence all the advantage ariſing from ſuch a machine, conſiſts only in that the rope does not wear off, and that it turns eaſier round the orb *b d*.

Hence a ſingle *pulley*, if the lines of direction of the power and the weight be tangents to the periphery neither aſſiſts nor impedes the power, but only changes its direction.

The uſe of the *pulley* therefore is, when the vertical direction of a power is to be changed into an horizontal one, or an aſcending direction into a deſcending one, and on the contrary.

But the great uſe of the *pulley* is, where ſeveral of them are combined; thus forming what *Vitruvius* and others after him called *Polyſpaſta*; the advantages whereof are, that the machine takes up but little room, is eaſily removed, and raiſes a very great weight.

As in my 10th figure, where there are two rundles, whoſe axis is immobile, *viz. a*, and the other whoſe axis is mobile, *viz. b*, of which a weight, *v. gr.* of a hundred pounds, depends; therefore if the rope be tied at one end to the nail *c*, and the other end be pulled by the power, I ſay, that the force of fifty pounds in the power *f*, is equivalent to the weight *d* of a hundred pounds; or the force of the hand *f* is double that it ſhould have without the aſſiſtance of the mobile rundle; for when the ratio of the velocity or ſpace, and of the weight or bulk is reciprocal between the power and the weight, they are in æquilibrio. For if the weight be of a hundred pounds, and the power *f* of fifty only, *i. e.* if the weight be double the power, the power will move with double the celerity of the weight, becauſe while the weight *d* is lifted up through that interval which is between *b* and *a*, the power *f* will bring up two ſegments of the rope, *viz. b g* and *i l*, which together are equal to double the ſpace *b a*; and therefore will be moved twice faſter: therefore its force will be double, and if it be heavier than fifty pounds, it will lift up the rundle *b* with the weight *d*.

If there be two mobile rundles, *c* and *d*, *Fig.* 11. a rope be tied to the immobile axis of the rundle *b*, which may be carried round as well by the two mobile rundles *c* and *d*, as by the immobile *a* and *b*, and drawn by the power *o e*; I ſay, that the force of the power *o* is quadruplicate. For to raiſe up the weight *e* from the point *c* to the point *b*, the power *o* muſt pull four ſegments of the rope, viz. *f g*, *h i*, *k l*, and *m n*, equal to the altitude *c b*; therefore the power muſt move four times faſter than the weight.

But we muſt obſerve, that the immobile rundles neither increaſe nor diminiſh the force of the power, but all increaſe of that kind proceeds from the moveable rundles, in the combined *pulleys*; and that force increaſes in proportion as the velocity of the power exceeds the velocity of the weight.

The WHEEL, is a ſimple machine conſiſting of a round piece of wood, metal or other matter, which revolves on an axis.

The *wheel* is one of the principal powers of *mechanicks*. It has places in moſt engines; in effect, it is of an aſſemblage of *wheels*, moſt of our chief engines are compoſed; as clocks, mills, *&c.*

Its form is various according to the motion it is to have, and the uſe it is to anſwer. By this it is diſtinguiſhed into *ſimple* and *dented*.

Simple wheels are thoſe, whoſe circumference and axis is uniform, and which are uſed ſingly, and not combined. Such are the *wheels* of carriages, which are to have a double motion; the one circular about their axis, the other rectilinear; by which they advance along the road, *&c.* which two motions they appear to have, though in effect they have but one, it being impoſſible the ſame thing ſhould move, or be agitated two different ways at the ſame time.

This one is a ſpiral motion, as is eaſily ſeen by fixing a piece of chalk on the face of the *wheel*, ſo that it may draw a line on a wall, as the *wheel* moves. The line it here traces is a juſt ſpiral, and ſtill the more curve as the chalk is fixed nearer the axis. A very nice phænomenon of the motion of this *wheel* is ſeen in *Rota Ariſtotelica*, which is the name of a celebrated problem in *mechanicks*; thus called, becauſe firſt, that we know of, taken notice by *Ariſtotle*.

The ſolution is to this effect. The *wheel* of a coach is only acted on, or drawn in a right line, inaſmuch as it defeats that direction; of conſequence the cauſes of the two motions, the one right, the other circular, are equal, and therefore their effects, *i. e.* the motions are equal. And hence, the *wheel* deſcribes a right line on the ground equal to its circumference.

For

For the nave of the *wheel*, the caſe is otherwiſe. It is drawn in a right line by the ſame force as the *wheel*, but it only turns round, becauſe the *wheel* turns, and can only turn with it, and at the ſame time therewith. Hence it follows, that its circular velocity is leſs than its rectilinear one.

Since then it neceſſarily deſcribes a right line equal to that of the *wheel*, it can only do it by ſliding, or what they call the motion of the *raſion*. That is, a part of the circular nave cannot be applied to a part of a right line greater than itſelf, but by ſliding along that part; and that more or leſs, as the part of the nave is leſs than that of the circle.

We ſhall add, that in *ſimple wheels* the height ſhould always be proportioned to the ſtature of the animal that draws or moves them. The rule is, that the load, and the axis of the *wheel* be of the ſame height with the power that moves them; otherwiſe the axis being higher than the leaſt, part of the load will lie on him, or if it be lower he pulls to diſadvantage, and muſt exert a greater force.

The power of theſe *wheels* reſults from the difference of the radii or ſpokes of the axis and circumference. The canon is this: as the radius of the axis is to that of the circumference, ſo is any power to the weight it can ſuſtain hereby.

This is alſo the rule in the axis in the peritochio, and in effect, the *wheel* and the axis in peritochio are the ſame thing; only in theory, it is uſually called by the latter name, and in practice by the former.

Dented wheels, are thoſe either whoſe circumference or axis is cut into teeth, by which they are capable of moving and acting on one another, and of being combined together. The uſe of theſe is very conſpicuous in clocks, jacks, *&c.*

The power of the *dented wheel* depends on the ſame principle as that of the ſimple one. It is only that to the ſimple axis in peritochio, what a combined lever is to a ſimple lever.

Its doctrine is comprized in the following canon, *viz.* The ratio of the power to the weight, in order for that to be equivalent to this, muſt be compounded of the ratio of the diameter of the axis of the laſt *wheel* to the diameter of the firſt; and of the ratio of the number of revolutions of the laſt *wheel*, to thoſe of the firſt in the ſame time. But this doctrine will deſerve a more particular explication.

Suppoſe the weight *a*, *Fig.* 12. which by its force can raiſe one pound, and is underſtood to move the *wheel b*, and the little *wheel c* joined to its axis; if we ſuppoſe that there are only ten teeth in the little wheel *c*, and an hundred in the wheel *b*, very well adapted to the former and joined to them; it will happen hence, that while the ſmall *wheel c* turns ten times round, the great wheel *d* will turn but once. Likewiſe if the ſame ratio be put between the ſmall *wheel c*, joined to the *wheel d*, and between the *wheel f* implicated to it, then while the ſmall *wheel e*, together with the *wheel d* turn ten times round, the *wheel f* will be conceived to turn only once round: therefore the firſt *wheel b* will turn round ten times ſwifter than *d*, and the *wheel d* ten times ſwifter than *f*; or which is the ſame, the *wheel b* will turn round a hundred times ſwifter than *f*.

If a power moves a weight by means of divers *wheels*, the ſpace paſſed over by the weight is to the ſpace of the power as the power to the weight. Hence the greater the power, the faſter is the weight moved, and *vice verſâ*.

Inclined Plane (which I place here, becauſe it has a near relation to the other three powers already explained) is a *plane* which makes an oblique angle with an horizontal *plane*: which *inclined plane* is to be ſeen in our plate of *Hydraulicks*.

We make uſe of an *inclined plane* to raiſe up, or let fall heavy bodies with a greater facility, whereby part of their weight is taken away; as workmen find by experience and without being taught. For when a great weight is to be carried to a high place, they put it on an *inclined plane*, which plane is ſometimes ſupported with boards or cylinders, for the conveniency of tranſporting it from one place to another.

The *laws of deſcent of bodies* or *inclined planes* are, 1. If a body be placed on an *inclined plane*, its relative gravity will be to its abſolute gravity, as the length of the plane to its height. Hence, 1. Since a ball gravitates on the *inclined plane* with its relative gravity; the weight applied in a direction parallel to the length of the plane, will retain or ſuſpend it, provided the weight be to that of the ball, as the altitude of the plane is to its length.

2. The abſolute gravity of the body is to its retractive gravity applied on the *inclined plane*, as the whole ſine to the ſine of the angle of inclination.

3. Hence the reſpective gravities of the ſame body on different *inclined planes*, are to each other as the ſines of the angle of inclination.

4. The greater therefore the reſpective gravity is, the greater is the angle of inclination.

5. As therefore in a vertical *plane*, where the inclination is greateſt, *viz.* perpendicular, the reſpective gravity degenerates into abſolute; ſo in an horizontal *plane*, where there is no inclination, the reſpective gravity vaniſhes.

To find the ſine of the angle of inclination of a *plane*, on which a given power will be able to ſuſtain

tain a given weight. Say, as the given weight is to the given power, ſo is the whole ſine to the ſine of the angle of inclination of the *plane*. Thus, ſuppoſe a weight of 1000 be to be ſuſtained by the power of 50, the angle of inclination will be found 2052.

If the weight deſcends according to the perpendicular direction, and raiſes up the weight in a direction parallel to the *inclined plane*; the height of the aſſent will be to that of the deſcent, as the ſine of the angle of inclination to the whole ſine.

The powers that raiſe weights through altitudes reciprocally proportional to them, are equal. This *Des Cartes* aſſumes as a principle whereby to demonſtrate the powers of machines; hence we ſee why a loaden waggon is drawn with more difficulty on an inclined than an horizontal plane; as being preſſed with a part of the weight, which is to the whole weight in a ratio of the altitude of the plane to its length.

A heavy body deſcends on an *inclined plane*, with a motion uniformly accelerated.

Hence, 1. The ſpaces of deſcent are in a duplicate ratio of the times, and likewiſe of the velocities; and therefore in equal times increaſe according to the unequal numbers, 1, 3, 5, 7, 9, *&c.*

2. The ſpace paſſed over by a heavy body deſcending on an *inclined plane*, is ſubduple of that which it would paſs over in the ſame time, with the velocity it has acquired at the end of its fall.

3. Heavy bodies therefore deſcend by the ſame laws on *inclined planes*, as in perpendicular planes. Hence it was that *Galileo*, to find the laws of perpendicular deſcents, made his experiments on *inclined planes*, in regard to the motions being ſlower in the latter than the former, as in the following theorem.

The velocity of a heavy body, bending on an *inclined plane*, at the end of any given time, is to the velocity which it would acquire in falling perpendicularly, in the ſame time, as the height of the *inclined plane* is to its length.

The WEDGE, *Fig.* 16. is a triangular priſm, whoſe baſes are equilateral acute-angled triangles.

Its doctrine is contained in this propoſition: If the power directly applied to the head of the *wedge*, be to the reſiſtance to be overcome by the *wedge*, as the thickneſs of the *wedge* is to its height, then the power will be equivalent to its reſiſtance; and if increaſed, will overcome it.

For the firmneſs whereby the parts of the obſtacles, ſuppoſe wood, adhere to one another, is the reſiſtance to be overcome by the *wedge*.

Hence, if the thickneſs of the *wedge* (that is, the way of the impediment, and conſequently its velocity) be to the height of the *wedge* (that is the way, and conſequently the velocity of the power) as the power of the impediment, or reſiſtance; then the momentum of the power, and the impediment, will be equal the one to the other; and conſequently the power, being increaſed, will overcome the reſiſtance.

Hence, 1. The power equivalent to half the reſiſtance, is to it as the whole ſine to the co-tangent of half the angle of the *wedge*.—And, 2. As the tangent of a leſs angle is leſs than that of a greater, the power muſt have a greater proportion to half the reſiſtance, if the angle be greater than if leſs. Conſequently the acuter the *wedge* is, the more does it increaſe the power.

To the *wedge* may be referred all edge-tools, and inſtruments which have a ſharp point, in order to cut, cleave, ſlit, chop, pierce, bore, or the like; as knives, hatchets, ſwords, bodkins, *&c.*

The SCREW, is a right cylinder, furrowed ſpiral-wiſe, chiefly uſed in preſſing or ſqueezing bodies cloſe, though ſometimes alſo in raiſing weights.

If the furrowed ſurface be convex, the *ſcrew* is ſaid to be *male*; if concave it is *female*.

The *doctrine of the ſcrew* is,—1. As the compaſs deſcribed by the power in one turn of the *ſcrew*, is to the interval or diſtance between any two immediate threads or ſpiral winding, ſo is the weight or reſiſtance to the power; then the power and the reſiſtance will be equivalent one to the other; and conſequently, the power being a little increaſed will overcome the reſiſtance.

2. As the diſtance between two threads is leſs, the power required to overcome the ſaid reſiſtance is leſs; therefore the finer the thread the eaſier the motion.

3. If the male *ſcrew* be turned in the female at reſt, a leſs power will be required to overcome the reſiſtance.

4. The diſtance of the power from the center of the *ſcrew*, the diſtance of two threads, and the power to be applied being given, to determine the reſiſtance it will overcome; or the reſiſtance being given, to find the power neceſſary to overcome it.

Find the periphery of a circle deſcribed by a radius, then the diſtance between the two threads, the periphery juſt found, and the given power; or to the periphery found, the diſtance of the two threads, and the given reſiſtance, find a fourth proportional. This in the former caſe will be the reſiſtance that will be overcome by the given power; and in the latter the power neceſſary to overcome the given reſiſtance.

E. gr. Suppoſe the reſiſtance between the two threads 3, the diſtance of the power from the center of the *ſcrew* 25, and the power 30 pounds, the periphery

periphery of the circle to be deſcribed by the power, will be found 157: Therefore, as 3, 157: 30, 1570, the weight to which the reſiſtance is equal.

5. The reſiſtance to be overcome by a given power being given; to determine the diameter of the *ſcrew* the diſtance of two threads, and the length of the ſcytala or handle: the diſtance of the threads, and the diameter of the *ſcrew* may be aſſumed at pleaſure, if the male be to be turned in the female by a handle: then as the given power is to the reſiſtance it is to overcome, ſo is the diſtance of the threads to a fourth number, which will be the periphery to be deſcribed by the handle, in a turn of the *ſcrew*. The ſemi-diameter of this periphery therefore being ſought, we have the length of the handle; but if the female *ſcrew* be to be turned about the male without any handle, then the periphery and ſemi-diameter found, will be very nearly thoſe of the *ſcrew* required.

E. gr. Suppoſe the weight 6000, the power 100, and the diſtance of the threads 2 lines; for the periphery to be paſſed over by the power, ſay, as 100, 6000: 2, 120; the ſemi-diameter of which periphery being $\frac{1}{3}$ of 120=40 lines will be the length of the handle, if any be uſed; otherwiſe the ſide of the female *ſcrew* muſt be 40 lines.

There are, beſides the above-mentioned *ſcrews*, the *endleſs ſcrew*, and *Archimedes's ſcrew*.

The *endleſs* SCREW, is a *ſcrew* fitted to turn a dented wheel, called *endleſs*, or *perpetual*, in regard it may be turned for ever, without coming at an end. From the ſcheme it is evident enough, that while the *ſcrew* turns once round, the wheel only advances the diſtance of a tooth.

The *doctrine of the endleſs* SCREW, is:—If the power applied to the lever, or handle of an *endleſs ſcrew*, be to the weight, in a ratio compounded of the periphery of the axis of the wheel, to the periphery deſcribed by the power, in turning the handle, and of the revolutions of the wheel, to the revolutions of the *ſcrew*, the power will be equivalent to the weight.

Hence, 1. As the motion of the wheel is exceedingly ſlow, a ſmall power may raiſe a vaſt weight, by means of an *endleſs ſcrew*: for this reaſon, the great uſe of the *endleſs ſcrew*, is either where a great weight is to be raiſed through a little ſpace; or where a very ſlow, gentle motion is required: on which account it is very uſeful in clocks and watches.

2. The number of teeth, the diſtance of the power from the center of the *ſcrew*, the radius of the axis, and the power being given, to find the weight it will raiſe.

Multiply the diſtance of the power from the centre of the *ſcrew* into the number of teeth: the product is the ſpace of the power paſſed through, in the time the weight paſſes through a ſpace equal to the periphery of the axis. Find a fourth proportional to the radius of the axis, the ſpace of the power now found and the power; this will be the weight the power is able to ſuſtain.

Archimedes's SCREW, or the *ſpiral pump*, is a machine for the raiſing of water, invented by *Archimedes*. Its ſtructure is as follows:

A leaden tube is wound round a cylinder, after the ſame manner as the ſpiral thread is drawn in the common *ſcrew* above deſcribed. This cylinder is inclined to the horizon in an angle of about 15 degrees, and the orifice of the tube immerged under water. If then the *ſcrew* be turned about by the handle, againſt the water; the water will raiſe up the ſpiral and be diſcharged at the other orifice of the cylinder.

This machine (whoſe figure is the ſecond in the plate of *Hydraulicks*) with a very little ſtrength, is able to raiſe a great quantity of water: whence it is found of good uſe in emptying of lakes, *&c.*

If the water be to be raiſed to any conſiderable height, one *ſcrew* will not ſuffice; but the water drawn up by one, is to be taken by another, and ſo ſucceſſively.

As the *mechanicks* are founded on *motion*, attempts have been made, from time to time, to find out a *perpetual motion*, i. e. a motion which is ſupplied and renewed from itſelf, without the intervention of any external cauſe; or in an uninterrupted communication of the ſame degree of motion from one part of matter to another, in a circle (or other curve returning it into itſelf) ſo as the ſame momentum ſtill returns undiminiſhed upon the firſt mover.

To find a *perpetual* MOTION, or conſtruct an engine, *&c.* which ſhall have ſuch a motion, is a famous problem that has employed the mathematicians for 2000 years.

Infinite are the ſchemes, deſigns, plans, engines, wheels, *&c.* to which this longed for *perpetual motion* has given birth; but there ſeems but little in nature to countenance all this aſſiduity and expectation: among all the laws of matter and motion, we know of none yet, which ſeems to lay any principle or foundation for ſuch an effect.

The whole buſineſs of finding a *perpetual motion*, comes to this, *viz.* to make a weight heavier than itſelf, or an elaſtick force greater than itſelf; or, there muſt be ſome method of gaining a force equivalent to what is loſt, by the artful diſpoſition, and combination of *mechanick powers*: to which laſt point, then, all endeavours are directed: but how, or by what means ſuch force ſhould be gained, is ſtill a myſtery!

As

As *motion* is the foundation of *mechanics*, it will be proper to add ſomewhat concerning the affections, cauſes, &c. of *local motion*.

Philoſophers, both antient and modern, agree among themſelves, that the *local motion* is a certain ſtate, or manner of the mobile body, whereby it correſponds ſucceſſively to ſeveral different places: But whether *reſt* be ſomething real and poſitive, is what is much controverted. *Ariſtotle*, *lib.* 5. *phyſic. c.* 8. and all the *Peripatetians* believe, that *reſt* is nothing but a privation of *motion*. And *Des Cartes* is of opinion, that *reſt* is no leſs real and poſitive than *motion* itſelf. In which controverſy I'll chuſe the medium: for *reſt*, as I take it, can be defined *the remaining of a body in the ſame place or ſpace:* therefore it can be called either a ſtate, or manner, or relation; and not a ſole privation of motion, as *Ariſtotle* imagined it; much leſs is it to be conſidered, as ſome poſitive or real faculty in a body, whereby it can act or reſiſt, as *Des Cartes* will have it.

It may be objected againſt my ſentiment, by the *Peripatetitians*, that reſt conſiſts in that, which once admitted, its nature is eaſily underſtood; as it happens by admitting only the privation of motion, as darkneſs is underſtood by admitting only the privation of light.

To which I anſwer, that neither reſt is underſtood by the ſole privation of *motion*, nor *motion* underſtood, by the ſole privation of reſt, but either ſtate is poſitive, one whereby a body correſponds to the different parts of the place, and the other whereby it correſponds to the ſame parts of a place; one or the other of thoſe manners being always in a body. For if it ceaſes from moving it reſts, and if it ceaſes from reſting it is moved: whence *motion* and *reſt* alternately ſucceed each other in a body.

As *motion* is the tranſlation of a body from one place to another, which wants time to be accompliſhed; we ſhould, therefore, underſtand the nature of *time* and *place*.

TIME, is *the ſucceſſive duration of a thing which has a beginning, and which can have an end.* It is called *a ſucceſſive duration*, becauſe *time* does not exiſt together. 2. *Which has a beginning, and can have an end*, becauſe time belongs to created things, which God has formed of nothing, and can reduce to nothing.

The name of *place* is ambiguous; for ſometimes it ſignifies the ſuperficies of a body, wherein another body is contained, ſometimes a ſpace, which can be occupied by all ſorts of bodies; the firſt is called an *internal place*, and the other *external*.

I conſider the ſuperficies of the ambient body in two manners, *viz. phyſically*, and *mathematically*.—It is conſidered *phyſically*, when conſidered in a phyſical body, endued with ſeveral ſenſible qualities, *viz.* fluidity, mobility, *&c.* and *mathematically*, when conſidered as in an extended ſubſtance, or in the ſole extenſion, abſtracted mutually, from ſenſible qualities: theſe preſuppoſed,

I ſay, that the *external place*, or *place* properly called, *viz.* the concave ſuperficies of an ambient body containing another body, is in fact, and *phyſically* mobile, becauſe it is continently moved, as it appears either in the air we are environed with, and which is agitated around us; or in running water, which waſhes the piles of a bridge.

But the *external place* conſidered *mathematically*, can be conceived immobile, becauſe in it the ſole extenſion is conſidered, as abſtracted from the reſt of the phyſical qualities, *viz.* fluidity, mobility, *&c.*

COROLLARY. When *motion* is defined the tranſlation of a body from a place into another, *place* is conſidered *mathematically*, not *phyſically*.

The principal affections of *motion* are its *quantity*, *determination*, *reflection*, and *refraction*.

The *quantity of* MOTION is the anſwer to the queſtion, *how great is the motion*, or that whereby any *motion* compared with another, is ſaid to be either greater or leſs than that it is compared with. And this is to be taken from two chiefs, *viz.* from the bulk or weight of a mobile body, and from the velocity of the motion.

Therefore if the two bodies A and B, *Fig.* 16. are equal in bulk, and are moved with an equal celerity, there will be as much *motion* in one as there is in the other; but if one of them, *viz.* A, is moved with twice the celerity of the other, it will have twice the quantity of motion B has. Likewiſe if both be carried with the ſame velocity, and one be twice, or thrice, or four times the other, it will have twice, thrice, four times, the quantity of motion.

For if ſome force is uſed to throw, *v. gr.* a body of a pound weight at fifty feet diſtance, within the time of the ſecond of an hour, the ſame force muſt neceſſarily be double, to throw it within the ſame time, at a hundred feet diſtance; and then the quantity of motion in it will be double.

For the ſame reaſon, if a body of a pound weight be carried with a certain force, within a minute's time to two hundred paces, certainly a body of two pounds will be moved, and within the ſame time, to a hundred paces; notwithſtanding which there will be the ſame quantity of motion in both, becauſe the force of the leſſer weight is followed with a greater velocity. Therefore the particles of the firſt element of *Des Cartes* muſt be moved with a far greater celerity with the ſame quantity of motion, than thoſe of the ſecond

element, becauſe the firſt element is much thinner than the ſecond.

The DETERMINATION *of motion*, is *the direction thereof towards one part, rather than towards another.* Whence *motion* is taken from the impulſive faculty, which is ſometimes greater and ſometimes leſſer; and the *determination* is to be deduced from the manner whereby the impulſion is made, *v. gr.* when a ball is thrown with the battler againſt a wall, the *motion* proceeds from the blow or percuſſion; but the *determination* depends on the manner of throwing it, *viz.* from the different ſituation of the battler, which ſituation cauſes that the fall deſcribes one line rather than another. For nothing hinders a motion which is not interrupted, from being preſerved in a mobile body, though the *determination* be changed; *v. g.* when a ball falls obliquely into a wall and returns back, the determination thereof is changed, though the ſame motion continues.

Hence, though *motion* with regard to itſelf is to be ſaid *ſimple*, and the mobile deſcribes one line only, either right or curve, when moved from one point into another, we notwithſtanding conceive ſometimes two or more *determinations* in it; and the *motion* is ſaid to be compoſed in ſome manner, of thoſe two or more *determinations*, viz. where two or more cauſes endeavour to move ſeparately one and the ſame mobile into different parts, *v. g.* if one would croſs a river from B to D. *Fig.* 18. and be carried by almoſt the ſame rapidity of the water into G, whereby he is carried into D; then he'll follow neither the right line A G, nor the right A D, but the line A K. For if he had arrived at firſt by his own ſtrength to the point B, he ſhould have arrived at the point E by the ſtrength of the river. Therefore to anſwer thoſe two motions, *i. e.* to arrive at the point D, through that interval, which is between A and B; and to the point G, through that interval, which is between A and E, it is certainly neceſſary, that he ſhould be at the firſt inſtant in the point H, at the ſecond inſtant in the point I, and at the third in K.

The REFLECTION *of motion* in a mobile body, is *the regreſs of the mobile body from another body it cannot penetrate.* As when a ball be thrown againſt a wall, as it cannot penetrate the wall, and is endued with an elaſtick faculty, immediately returns back.

But when a body is thrown againſt another, it falls againſt it, either perpendicularly and directly, or obliquely; if it falls perpendicularly, and is capable of reflection, it muſt meaſure quite the ſame line, ſince there is no reaſon why it ſhould incline to one part rather than another, *v. gr.* when a bladder blown is thrown againſt the pavement, it is obſerved to return back according to the ſame perpendicular line.

But if that body falls obliquely againſt another, *viz.* if a ball be thrown according to the line A B, *Fig.* 19. againſt the line C B, in ſuch a manner as to form with it the angle A B C, leſs than a right one, then it will reflect on the other part, and keep the ſame inclination towards the ſuperficies B E, or from another angle equal to the former: the former is an *angle of incidence*, and the latter an *angle of reflection*; and thoſe angles, if the contact be made on a ſmooth and poliſhed ſuperficies, and meet with no obſtruction, muſt be equal, as is ſhewn in the ſecond diſſertation of *Des Cartes*'s Dioptricks, in this manner.

Let it be the ball A, *Fig.* 20. which is carried through the line A B, into the point B; its motion is underſtood to be compoſed of two others, *viz.* of a perpendicular, whereby it arrives at the line C B E, and of a horizontal, whereby it arrives at the line G B H, or tends towards D E F: whence it may be imagined, that the ball is impelled by a double power at once, *viz.* by one power, according to the perpendicular line A C; and by another, according to the horizontal line A R D. If thoſe faculties or powers be ſuppoſed equal, the line A C will be equal to the line A R, or C B; becauſe the ball advances as much by an horizontal motion, as it is thrown by a perpendicular one; and therefore the line A B will be the diagonal of the perfect ſquare A C B R, but if the faculties be ſuppoſed unequal, or if the motion is ſaid to be made according to a more oblique line, another proportion will be obſerved between the faculties or powers, and thoſe lines perpendicular and horizontal, and ſuch as the power will be to the power, ſuch will be the line to the other line.

For when the ball will have touched the point B in the ſuperficies or line C B E, which oppoſes the perpendicular *motion*, not the horizontal, it will change its perpendicular motion, not the horizontal: but though the determination be changed, the motion does not immediately ceaſe, for the ball returns with almoſt the ſame force it was thrown with. Hence it follows, that when it advances forward horizontally according to the length E D equal to itſelf C B, it will advance forward by a perpendicular motion according to the length E D equal to A C; ſo as for the angle of reflection D B E, to be equal to the angle of *incidence* A B C.

The ſame happens if C B E, *Fig.* 21. be imagined to be a ſmall cord, extended from the point

L to the point M, againſt which is thrown the ball A, according to the line A B, for then the cord will be bowed according to the perpendicular line B *i* K, to the point *i*, or thereabouts, and not according to the oblique line B *n f* to the point *n*; becauſe the motion or inflection is eaſier and ſhorter, according to the perpendicular line, than according to the obliqueous: therefore that cord by its elaſticity will reflect the ball in G; but when otherwiſe, the ball with the ſame force tends by a horizontal motion towards the point E, it muſt come back through the diagonal line B D, which is the middle line between both; and thus will form an angle of reflection equal to the angle of incidence. *See* the doctrine of *projectiles* under the article *Gunnery*.

As to the REFRACTION *of motion* — As often as a mobile body paſſes from a liquid one, into another liquid of a different kind, which it penetrates and divides, it is not reflected by it, but it ſometimes ſuffers another mutation, called *refraction*.

REFRACTION, is the *inflection of motion, whereby a mobile body, according to the greater or leſſer reſiſtance of the liquid, which it enters obliquely, declines from its right line.* Therefore a mobile body falling perpendicularly on a liquid of a different kind, ſuffers no *refraction*, *viz.* if the ball A, *Fig.* 22. falls perpendicularly from the air into water, and begins to penetrate it in the point E, it will deſcend, by a right way, into B; ſince no reaſon occurs why it ſhould incline more on one part than on the other. But if a mobile body, *viz.* a ball, enters the water in an obliqueous manner, then it will recede from the right way; in which receſs, gravity and levity can produce ſome variation.

But as the doctrine of *refraction* regards, particularly, light, which we'll prove afterwards to be placed in a ſmall body preſſed and moved, it ſeems more proper to explain it in the rays of the light, in which there is properly neither gravity nor levity.

Let therefore the ray of light be *a b*, *Fig.* 23. which paſſes obliquely from the air into water, as it muſt on its way tend towards *c*, it will be refracted in *b*, in approaching the perpendicular *e f*.

If it had come from *d*, and paſſed from the water into the air, as ſoon as it had arrived at *b*, it had not proceeded forwards to *g*, but receding from the perpendicular line *e f*, it had inclined towards the point *a*.

Which to underſtand, you muſt conceive the ſolid ray *k k i l*, which falls obliquely into the water, where its point *i* ſhall reach the ſuperficies of the water, while the point *b* will be ſtill in the air: and as the reſiſtance of the water is greater than that of the air, while the point *i* ſhall run through the ſpace *i m*, the point *l* ſhall run through the ſpace *l n*, which is much greater than the ſpace *i m*, as the reſiſtance of the water is much greater than that of the air: the one and the other motion *l n* and *i m*, is underſtood to be made circular, and round the center *r*, in which the line *l i* and *a m* are formed.

But when the line *i l* will be arrived at *m n*, and the whole ray ſhall touch the water with its anterior parts, it will find the ſame reſiſtance every where; and thus will advance towards the part *o d p*, by a right motion, and not a circular one.

On the contrary, if the radius *o p m n* was to come out of the water, its point *n* would reach the air ſooner than the point *m*; therefore while the point *n*, by a circular motion were moved into *l*, the point *m* ſhould likewiſe be moved into *i*; and then both by the force of the water, and a direct way ſhould tend towards K L, in receding from the perpendicular.

From this I'll paſs to the true and proper cauſe of *motion*.

We call, 1. In metaphyſicks, the true and proper efficient cauſe of *motion*, that which truly and properly produces *motion* in bodies, or which imprints a motion in them, or in a word moves them. — 2. To move the bodies, is to carry them from one place into another, by a continual fluctuation.

COROLLARY. The *motion* of bodies does not properly proceed from themſelves, ſince they can neither carry themſelves nor other bodies from one place into another; the faculty of moving themſelves, or communicating a *motion* to other bodies is not contained in their nature, and they are clearly and diſtinctly conceived without a faculty or active principle of motion.

The occaſion of the motion of the large and ſenſible bodies draws its beginning from a ſubtile and fluid matter, which the author of nature keeps in a perpetual motion; which can be demonſtrated by induction: for, *v. gr.* in a watch, the motion of the index, which ſhews the hours, proceeds from the wheels, and the wheels are put in motion by the ſpring incloſed in the barrel; which ſpring does not move itſelf, but receives its motion from the ſubtile matter; which matter receives its motion from the firſt mover of all things.

A body can be the occaſional cauſe of another body; as when the ſubtile matter runs againſt the large bodies, or ſomebody puſhes a ball againſt another ball: thus incurſion, or impulſion, is the

occaſion of the author of nature transferring thoſe bodies into another place, according to the law he has preſcribed to himſelf.

The natural bodies can be very well called the ſecond nature; and neareſt cauſes of *motions*, or natural effects; becauſe thoſe cauſes are employed by the author of nature to produce thoſe effects: *v. gr.* the ſun to produce light and heat.

The firſt and ſecond cauſe of a continued motion in a body, is the ſame with the cauſe of the firſt motion.

COROLLARY I. A *motion* once imprinted into a body, continues always in it, till it be ſtopt by an outward cauſe, *viz.* by the bodies it meets in its way; becauſe it cannot be changed or deſtroyed by that body into which it is received; ſince all body be idle of itſelf. Whence if it was moved in the vacuum, or rather in a ſpace in which there were no reſiſtance, its motion would be perpetual.

COROLLARY II. There is no definite term, towards which the motion tends, unleſs what proceeds from the bodies it meet in its way; for without thoſe bodies the motion would be perpetual, and never interrupted, as we have already obſerved, and is plainly ſeen in the planets, the revolution whereof is perpetual.

The next thing which falls under our conſideration is, *the cauſe of the reflected motion*; wherein I'll treat of *the elaſticity of the bod es*.

ELASTICITY, or the *elaſtick faculty of bodies*, is the power of reſtoring itſelf to its former ſtate; as when the branch of a tree, which was bowed returns to its former ſtate of extenſion. Therefore a body, to be called *elaſtick*, muſt be firſt preſſed or bowed, retaining all the while the power to reaſſume its former ſtate.

COROLLARY. An *elaſtick body* muſt have at leaſt ſome rigidity or hardneſs in its parts, whereby to ſupport as much as poſſible its form, otherwiſe it would never endeavour to recover its former ſtate.

Which notwithſtanding the ſole rigidity of the parts ought not to be conſidered as the proper cauſe of *elaſticity*, ſince rigidity is in ſome meaſure the ſame with the *elaſtick faculty*, or at leaſt proceeds from the ſame principle: which, when we conſider with a great deal of attention, the nature of bodies, it ſeems to be nothing elſe but a certain ſubtile matter, which runs through the meatus of the larger bodies; which ſentiment, which is that of *Des Cartes*, can be confirmed by ſeveral examples.

For, 1. When an ivory ball falls on the pavement, the parts where the contact is made, are plained, and conſequently the paſſages of the ſubtile matter, cloſed. But the ſubtile matter, to flow more freely, endeavours to dilate thoſe paſſages or meatus, by penetrating them: which it is impoſſible it ſhould accompliſh, without either removing the pavement, or lifting up the ball. But it is more eaſy to lift up the ball, than to remove the pavement; therefore it lifts up the ball, and reſtores it to its former ſtate. Let the ball be *a d b*, *Fig.* 25. in which the part *a* be compreſſed in ſuch a manner, as for the motion of the ſubtile matter from the part *c* through the part *b* to *d* and *e* to be retarded: then certainly that matter by the continual impulſion whereby it endeavours to dilate the pores of the ball, will reſtore to the ball its former ſhape. But as the ball received by the battler, not only becomes more plain in thoſe parts which touch the the battler, but even bends the net of the battler, by the *elaſticity* thereof it is repercuſſed; likewiſe an ivory ball falling on a marble table, is reflected, as well by its own *elaſticity*, as by that of the table.

Secondly, The ſame thing may be obſerved in the ſpring incloſed in the barrel of a watch; for if the ſpring be inflected, the pores in the convex ſuperficies are dilated, and cloſed in the concave. Whence the coarſer particles of the ſubtile matter, may enter the convex ſuperficies, but cannot penetrate the concave: and therefore endeavour to reſtore by their penchant, and preſſion, the body to its former ſtate. Here it happens, that the ſubtile matter which flows continually, lengthwiſe, from one extreme of the ſpring to the other, affects as much as poſſible a right line, and conſequently endeavours to extend the ſpring.

Next follow reflections on the *cauſe of a tranſlated motion, where I'll treat of the laws of motions, obſerved in the colliſion of bodies.*

As God is the author of all motions, he has, notwithſtanding, eſtabliſhed cauſes, which are the occaſion of his creating various motions; which cauſes are commonly called *ſecond* or *natural*, and by modern Philoſophers, *occaſional*. Whence tho' bodies conſidered in themſelves, are only accounted paſſive, not active; if notwithſtanding they be conſider'd with reſpect to the bodies they touch or impel, they are ſaid to act on them.

But with what proportion one body operates on another, and communicates to it its motion, and which are the laws eſtabliſhed by the author of nature, in the colliſion of bodies, is what can be diſcover'd only by obſerving carefully their natural effects, and a long meditation.

Des Cartes, who firſt of all attempted that diſcovery, ſays, *firſt*, That all bodies remain in that ſtate in which they were once placed, till that ſtate be changed by the encounter of other bodies. Thus we ſee a matter, which is ſquare, retaining always the ſame figure, till ſomething happens from another

ther part, which makes it change that figure. For the ſame reaſon, when the matter is at reſt, it can be excited to motion by another cauſe, but not of itſelf: that when it is moved, it continues in motion as long as it meets with nothing to ſtop its motion.

Secondly, That every part of matter which is moved, affects always a right line, though by the encounter of other bodies, it often ſteps out of the right road, and acquires a circular motion; as it happens in a river, the water whereof running againſt the pile of a bridge, returns back, and acquires a circular motion, when it ſhould have followed the ſtrait way, if it had met with no obſtruction to change its determination.

Hence it is that the ſtone *a*, *Fig.* 26. turn'd round in a ſling, by letting ſlip one of the chords of the ſling, is thrown according to the right line *a g*, which right line is the *tangent* of the circle, delineated by the ſling, *i. e.* it touches it in the point *a*.

Likewiſe, if corn, or any other minute bodies, be put on a mill-ſtone, turning round, and are carried by the motion of the mill-ſtone, they'll come out of it according to the tangent-lines. Whence it may be inferr'd, that all that's moved, even of a circular motion, affects always a right line, and recedes as much as poſſible from the center of motion; which is of a great uſe in phyſick.

Thirdly, *Des Cartes* adds, that as often as a body, which is in motion, meets with another, if it has a leſſer force to go forward according to a right line, than the other has to hinder it; then it reflects on the oppoſite part; and retaining its motion, changes only the determination of motion.

And that if a body, in motion, falls on a weaker body, all the motion it communicates to it, it loſes it. So that if a hard body encounters againſt a ſoft body, it transfers all its motion to it, *v. gr.* if a ball be thrown into a heap of duſt, the whole impetuoſity of the ball paſſes into the heap of duſt, or into the ambient air, and is thereby entirely ſtopped. I do not ſee that this latter part contains any thing contrary to reaſon.

The percuſſion of two bodies can be made in two manners: for either both run mutually againſt one another from oppoſite parts; or one runs againſt another, which is at reſt: or both are carried towards the ſame part, ſo that the body which is laſt, is moved with a greater celerity, and overtakes that which is foremoſt.

If they run againſt one another from oppoſite parts: they are either equal in bulk and velocity, or are equal in velocity, and unequal in bulk or weight; or laſtly, are equal in weight, and unequal in velocity.

If one of them runs againſt another which is at reſt, or that which is leſs runs againſt a bigger, or a big one falls on a leſſer; or an equal runs againſt another equal. Theſe three rules are explain'd by the fourth, fifth, and ſixth rule of *Des Cartes*.

If both are moved towards the ſame part; or an equal body overtakes another equal body; or a leſſer body overtakes a bigger; or laſtly, a greater overtakes a leſs. Whence three rules can likewiſe be eſtabliſhed, relating to this third manner of percuſſion: but *Des Cartes* has eſtabliſhed but one rule for it, *viz.* the ſeventh. For he has propoſed ſeven rules of the communication of *motions*, in the ſecond part of the principles, *Num.* 46. and following.

The firſt is thus: *If two equal bodies, as* A *and* B, Fig. 27. *directed from oppoſite parts with an equal celerity, encounter one another, after the colliſion, they will reflect with an equal celerity towards the place whence they departed.* For there is no cauſe why the motion ſhould periſh, but the determinations muſt be changed.

The firſt rule is obſerved in elaſtick bodies; for in thoſe which have no elaſticity; whether they be inflexible, as imagined by *Des Cartes*, or ſoft, it has no place; becauſe the oppoſite determinations in bodies deſtitute of elaſticity, deſtroy mutually one another; and thoſe bodies are only ſtopped by one another, but do not reflect.

But to apply theſe, and the following rules to experiments; and to imprint a certain quantity of motion into a body, comparatively to another; we commonly take two points in a wall, perpendicularly erected, *viz.* *a* and *b*, *Fig.* 28. to which we affix two nails, from which hang two threads *a g* and *b h*, whereby are deſcribed the two arches of a circle *h l f* and *g i c*, equal between themſelves, and diſtributed into equal diviſions. For then if the two equal balls *g* and *h*, ſuſpended by thoſe two threads, be both thrown down from the ſame height, they will run from oppoſite parts againſt one another in the point *m*, with an equal velocity of motion.

Therefore if they be both elaſticks, *viz.* either marble, or ivory, *&c.* then after the colliſion, they'll reflect with the ſame celerity to almoſt the ſame height from whence they were thrown. For if an elaſtick ball hits another elaſtick ball with the ſame force it was hit with by that other elaſtick ball; and if there was not a little obſtacle as well from the gravity of the ball, as from the reſiſtance of the air, they would mutually repel one another to the ſame place from which they were thrown.

But if the balls be deſtitute of elaſticity, *viz.* if they be made of ſoft clay, both, after the colliſion, will remain immoveable in the point *m*. Though it muſt not be inferred hence, that their motion is entirely

entirely periſhed; for it is transferred either into the parts of the balls, which being ſoft, are compreſſed, or ſwell in the form of a belly, or into the incumbent air, and ſubtile matter.

The ſecond rule.—*If the bodies be unequal, and puſhed againſt one another with an equal velocity; the leſſer body ſhall reflect with the ſame celerity, and both advance together towards the ſame part.* This rule ſeems to me contrary to experience, even in bodies deſtitute of elaſticity, from which *Des Cartes* has eſtabliſhed it. For if the two bodies, *g* and *h*, be ſoft, ſo that *g* be twice as big as *h*, and both thrown from the ſame height (*viz.* from *i* and *h*, *Fig.* 28) the body *h* will fly back, but not with the ſame celerity it came down, for the motion of the leſſer body will take from the motion of the bigger one a part equal to itſelf, and both move towards the part *f*, with that quantity of motion whereby the body *h* was ſurpaſſed by the body *g*, before their encounter.

But if thoſe bodies deſtitute of elaſticity, whether they be inflexible or ſoft, are ſuppoſed to have velocities reciprocal with the bulk; ſo that *v. gr.* the body *g* be twice the body *h*, but, *viciſſim*, and moved twice ſlower, *viz.* if the body *g* be thrown from the point *i*, and the body *h* from the point *f*, which is twice farther, both after the colliſion, will remain immoveable, as is plainly ſeen in two ſoft balls, *viz.* made of clay. But however, as the quantity of motion is deduced both from the bulk and velocity, a body twice leſſer than the other, but moved twice ſwifter, has the ſame motion as the other: hence it happens, that both reſt in the point *m*, as if they were equal, and fallen with an equal velocity.

The third rule.—*If bodies be equal in bulk, but are moved with an unequal velocity, that only which is moved ſlower, will return back after the encounter, and both will be moved with an equal celerity towards the ſame part*, v. gr. If the body *g* approaches with ſix degrees of celerity; and the body *h* with four only, *Fig.* 29. the ſole body *h* will return back after the colliſion, and the body *g*, beſides, will communicate to it one of its degrees of velocity, that both afterwards may ſeparately, with each five degrees of celerity, tend towards the ſame part.

But this rule is falſe, in that it can be adapted only to bodies deſtitute of elaſticity; and becauſe a leſſer quantity of motion remains in them after the colliſion, than it eſtabliſhes; for if the two ſoft bodies *g* and *h*, be ſuppoſed equal in bulk; and the body *g* runs with ſix degrees of velocity againſt the body *h* at reſt, it will communicate to it three degreee of its velocity, that both may be carried with the ſame velocity towards the ſame part. But if *h* runs againſt *g* with four degrees of velocity, as ſuppoſed in *Des Cartes*'s hypotheſis; then it will borrow four degrees of velocity from *g*, and both, after the colliſion, be moved towards the ſame part; ſo that the two degrees of velocity remaining in the body *g*, will be equally diſtributed in them.

But if thoſe equal bodies are ſaid to be elaſtick, and the body *g* be thrown from the height *c*; and *h* from the height *l* only, ſo as the velocity will be greater in the body *g* than in the body *h*, both after the percuſſion will permute their velocities, and the body *g* reflect only into the point *i*, and the body *h* into the point *f*. The reaſon whereof is, that the body *g* which is moved with more celerity, ſtrikes ſtronger the body *h* in the colliſion, than is ſtricken by it; hence they muſt change their velocities between them.

The fourth rule.—*If a body be leſs than another which is at reſt, with whatever celerity it may be puſhed againſt it, it will never communicate a motion to it, but will be reflected by it, into a contrary part*, v. gr. the body C C at reſt, never can be moved either by the body A or the body B, *Fig.* 30. becauſe a body at reſt reſiſts more to a greater celerity, than to a leſſer, and the greater the celerity is in a leſſer body, the more the reſiſtance increaſes in a greater.

But that rule, which eſtabliſhes reſt in a body, as ſomething real and poſitive, to reſiſt the motion of another body; can be demonſtrated contrary, both to reaſon and to experience.

And firſt it is contrary to experience: for if ſome ſofter body, *v. gr.* if the body *h* runs with three degrees of velocity againſt the body *g*, twice bigger and at reſt; it will communicate to it two degrees of its velocity, and both united, will run with one degree of celerity againſt a body three times bigger than the body *h*.

If thoſe bodies be elaſtick, and the leſſer body *h* moved, is ſaid to run againſt the greater *g* and at reſt, the leſſer body *h* will not (according to *Des Cartes*) return with all its motion, but will communicate ſomething of it to the greater body *g*, having regard to the motion of both, and to the elaſtick faculty.

This rule of *Des Cartes* is alſo contrary to reaſon; for that a leſſer body may be capable to give motion to a greater, it ſuffices that the reſt of the greater be not infinite, and the motion of the leſſer can be increaſed *in infinitum:* for hence it will happen at laſt, that the reſt of the greater will be conquered by the motion of the leſſer: but the reſt of the greater body is not infinite, ſince it is only attributed to the bulk, which is finite; but the motion of the leſſer body can be increaſed *in infinitum*, ſince it takes its quantity, not from the ſole bulk, which

which is finite; but likewiſe from velocity, which can be increaſed *in infinitum*.

Therefore a leſs body can give motion to a greater, and the fourth rule of *Des Cartes* is not only contrary to experience, but likewiſe to reaſon.

The fifth rule.—*If the bigger body C C hits the leſſer body A or B which is at reſt*, Fig. 31. *it tranſfers to it as much of its motion as is ſufficient to have them both moved with an equal velocity.* Let it be, for example, the body C C, which being double the body A, and having three degrees of velocity, will give one of them to it: for the body A will be equally moved with one degree, as the body C C with two.

This rule is agreeable to experience, ſince thoſe bodies, after colliſion, are united into one; but is not obſerved in elaſtick bodies: for when a greater body is puſhed againſt another body leſſer, and at reſt, though the greater begins to move towards the ſame part, it notwithſtanding communicates a greater celerity than that it has, though it does not give it a greater quantity of motion.

The ſixth rule.—*If the bodies A and B be equal, and the body B be at reſt, the body A hitting with four degrees of celerity againſt the body B, will communicate to it one of its degrees of celerity, and with the three degrees of celerity remaining, will reflect into a contrary part.*

This rule, even according to *Des Cartes*'s doctrine, is entirely falſe: for the body A muſt give half its motion to the body B equal to it and at reſt, that together they may advance towards the ſame parts, provided they be ſoft, and deſtitute of elaſticity; becauſe then they make but one body.

But if they be elaſticks the body A will ſtop, and tranſfer its whole motion to the body B which was at reſt before. For as the body A has two contrary determinations, one whereby it is carried into the body B, the other whereby it is repelled by its elaſticity, thoſe two determinations will mutually deſtroy one another, and conſequently the body A be neceſſarily ſtopped: but as the body B has only one determination, which it receives from the body A, it therefore will be moved with that quantity of motion which was in the body A.

Therefore if the body A be puſhed againſt the ſeveral bodies C D E F, for example, if a crown be thrown upon other crowns equal to it, all thoſe bodies will ſtop except the laſt; for if the body A, in the colliſion has two contrary determinations, the body B will have two likewiſe as well as D and E; ſo that the body *f* which is repelled by none, muſt be moved.

For the ſame reaſon, if two bodies be thrown againſt ſeveral others, they will all ſtop except the two laſt. If three were thrown, only the three laſt would be moved.

The ſeventh and laſt rule is a little longer and more intricate, and not true: the ſenſe of it is very near as follows.—*If B and C C*, Fig. 32. *be moved towards the ſame part, and C C which is double the other, goes foremoſt, but ſlower than B, ſo as to be at laſt overtaken by it, it can happen that B either will tranſfer part of its velocity to C C, or fly back with all its motion.*

For if the exceſs of celerity whereby B ſurpaſſes C C, be greater than the exceſs of magnitude, whereby C C ſurpaſſes B; then B will communicate to C C ſome of its motion; that both may be moved with an equal celerity towards the ſame part: but if the exceſs of celerity whereby B ſurpaſſes C C be leſs than the exceſs of magnitude whereby C C ſurpaſſes B, nothing of the motion of the body B will be tranſferred to C C; but the body B will fly back with all its motion.

This rule can be defended neither by experience, nor by reaſon: whence we muſt philoſophiſe in another manner, of the reaſon of that percuſſion, and diſtinguiſh three caſes.

For if the bodies in which the experiment is made be deſtitute of elaſticity, *viz. g* and *h*, *Fig.* 33. and are moved towards the ſame part ſlowly at firſt, and afterwards with great celerity; either both are equal, or that which precedes, *viz. h* is greater, or laſtly, that which follows, *viz. g* is greater.

If they be equal, and the body *g* is thrown down from the point *c*, and the body *h* from the point *i*; ſo that there be four degrees of velocity in the body *g*, and only two in the body *h*: after *g* ſhall have overtaken *h*, it will communicate to it one of the degrees of its celerity, that both together ſhould proceed forward with three degrees of velocity; which celerity is half the celerity of both bodies taken together: for 4 and 2 degrees is ſix, and half that ſum is 3.

Whence it may be inferred, that if the body *g* be greater than *h*, all other things ſuppoſed as before, *g* is not to communicate a whole degree of its celerity to *h*; but if it be leſſer, *g* muſt communicate to it more than one degree of its celerity, becauſe it is diſtributed according to the bulk. Therefore if when the bodies are equal, and the common velocity after the encounter be half the ſame compoſed of the former velocities; certainly when the body which is foremoſt will be leſſer than the other, the common velocity will be greater than half the ſum; and when that body will be greater, the common celerity is to be leſſer than half the ſum.

But if the bodies *g* and *h* be elaſtick and equal, after *g* will have overtook *h*, they'll interchange their velocities: for if the body *g* was to run, with four degrees of velocity againſt the body *h* at reſt,

it

it would hit it with all thoſe four degrees, and be repulſed by ſo many degrees afterwards by the elaſticity; and thus ſtop, having transferred its whole motion to the body *h*. Therefore if the body *h* flies with two degrees when hit by the body *g*, the percuſſion then will be of two degrees only: whence two degrees will be added to the body *h*, and two taken from the body *g*; and thus they will interchange their velocities.

At preſent I muſt ſay ſomething of the *acceleration of the heavy bodies in the deſcent*. For the intelligence of thoſe things, which have been happily diſcovered by our modern mathematicians, and have been publiſhed almoſt in our times, as well for the publick utility, as for the increaſe of learning: I ſay that,

Heavy bodies accelerate their motion in deſcending: and that acceleration very near follows the progreſs of the uneven numbers, 1, 3, 5, 7, ſince they are continually ſpurred on by the incumbent ſubtile matter; for as that ſubtile matter is always carried upwards, there is no reaſon or cauſe why its faculty or efficacy to force the heavy bodies downwards, ſhould be diminiſh'd or deſtroyed.

That that acceleration follows very near the progreſs of the uneven numbers, 1, 3, 5, 7, appears not only by the experiments of *Galileo*, but likewiſe of other famous Mathematicians, who by thoſe they have made, particularly at the Obſervatory, have found, that a body falling, runs within the ſecond of an hour, or the pulſation of an artery, one ſix feet; in the ſecond inſtant, three; in the third, five; or rather, if within a ſecond, it was fallen from the height of twelve feet; it fell within two ſeconds the height of forty-eight feet; and therefore, had run the ſecond time, thirty-ſix feet, *i. e.* three times the ſpace it had run the firſt time.

They have obſerved this in pendulums. For the ball being ſuſpended at a rod three feet, eight lines and a half long, it performs a ſingle vibration within the time of a ſecond. But if the rod be four times longer, *viz.* twelve feet, two inches, and ten lines, it will perform a ſingle vibration in twice the time, *viz.* in two ſeconds. So that to the firſt ſecond are allowed three feet, with eight lines and a half; and to the laſt, three times three feet, or nine feet, twenty-five lines and a half. If the pendulum be nine times longer, *viz.* twenty-ſeven feet, ſix inches, and four lines and a half, it deſcribes its arch within three ſeconds. For thoſe ſums, *viz.* three feet, with eight lines and a half; nine feet, with two inches, and one line and a half; fifteen feet, with three inches, and ſix lines and a half, make up the ſum of twenty-ſeven feet, ſix inches, and four lines and a half.

Therefore heavy bodies follow very near, in their deſcent, eſpecially in the leſſer diſtances, the progreſs of the uneven numbers, 1, 3, 5, 7, *&c.*

There is no other cauſe of acceleration of the the motion of heavy bodies in the deſcent, than *that* which firſt puſhes it downwards, *viz.* the liquid matter whereby it is continually depreſſed.

2. The ſpaces run through by a heavy body in falling, are, in *Galileo*'s hypotheſis, between them, as *quarters of times*. For if a heavy body in the firſt time, or pulſation of an artery, runs ſix feet, in the ſecond, nine, in the third, fifteen, *&c.* it will follow hence, that at the end of the ſecond time, it will have run twenty-four feet, *viz.* ſix within the firſt pulſation of an artery, and nine within the ſecond. And if thoſe twenty-four feet, are joined with twenty-eight, which it will run in the third time, they will make up fifty-two feet. And thus, at the end of the third time, it will be found to have run nine hexapedes; and four and nine are quadrate numbers.

This is commonly expreſſed, *Fig.* 30. in which the triangle, A 11, repreſents the ſpace run through at the firſt time; the three triangles compriſed within 11 and 22, the ſpace run through at the ſecond time, *&c.* For 2 and 2 are 4, which is a quadrate number, produced from a binary number, carried into itſelf. The ratio of all other angles is the ſame. Therefore the ſpaces run through by a heavy body in the hypotheſis of *Galileo*, which as the leſſer diſtances approaches nearer the truth, are between them as quarters of time.

The ſame is ſeen in pendulums; for a pendulum of three feet, eight lines and a half, accompliſhes its ſimple vibration within the ſpace of a ſecond; as we have already obſerved; a pendulum of twelve feet, two inches and ten lines, within two ſeconds; and a pendulum of twenty-ſeven feet, ſix inches and four lines and a half, within three ſeconds.

For 3, 12, and 27, are between them as 1, 4, and 9; for every where the firſt number is contained four times in the ſecond, and nine times in the third; 4 and 9 beſides are quarters of times, *viz.* of two and three ſeconds. Therefore the ſpaces run through by a heavy body, according to *Galileo*'s hypotheſis, are between them as quarters of times.

3. A heavy body, puſhed by a horizontal motion, *v. gr.* a leaden bullet exploded from a cannon, is carried by one motion only, and deſcribes but one line: but it is moved by two motrice faculties or powers. *viz.* by a *horizontal motion*, from

from the lighted gun powder, and by a *perpendicular one*, from its innate gravity, or rather the preſſion of the ſubtile ſubſtance. Therefore of that double motion, *viz.* horizontal and perpendicular, is formed a certain compoſite motion, whereby is deſcribed a curve line: which line, ſuch as it is, is made up in this manner.

The horizontal motion, the reſiſtance of the air excluded, follows the natural ſeries of the numbers, 1, 2, 3, 4; and the perpendicular motion advances forwards, according to the uneven numbers, 1, 3, 5, 7, as we have already obſerved. Therefore the line deſcribed by that double motion, the reſiſtance of the air excluded, is a *parabola*.

For, a PARABOLA, *is a line in which the quarters of the ordinates, are between them, as parts of a diameter intercepted by thoſe ordinates.* But a line deſcribed by a heavy body, thrown by a horizontal motion, is ſuch a line. For in *Fig.* 31. if the horizontal lines 1 *g*, 3 *h*, 5 *i*, 7 *k*. called ordinate, are between them as the numbers, 1, 2, 3, 4; and the parts 6 1, 1 3, 3 5, 5 7, follow the progreſſion of the uneven numbers, hence it can be underſtood that a quarter of the line 3 *h*, which is, *v. gr.* of two inches, is to a quarter of that line 5 *i*, which is of three inches, as *a b* 6 3 is to 6 5. For the quarter of the line 3 *h* of two inches is 4, and the quarter of the line 5 *i*, which is of three inches is 9: likewiſe 6 3, or 6, 1, 3, is 4; for it contains 1+3. Likewiſe 6 5, or 6, 1, 3, 5, is 9: For it contains 1+3+5. and thus the line *b g h i k*, which deſcribes the water flowing from the fountain *a* through the pipe *b*, is parabolick.

All projected bodies, provided they be not thrown upwards by a perpendicular motion (for then they re-meaſure the ſame line) deſcribe in their aſcent and deſcent, an entire parabola.

Let it be, *v. gr.* a bullet exploded from the cannon *p*. *Fig.* 32. and ſent according to the line *p m*, as it ſhould be carried into the point *m*, it will be carried by its own weight into the point *a*, then into *g i l o*; and that line *p a g i l o* is parabolick. For as the bullet by its horizontal motion, the reſiſtance of the air ſuppoſed, follows the ſeries of the natural numbers, 1, 2, 3, 4, the lines *f g*, *h i*, *k l*, *n o*, will be as 1, 2, 3, 4; but as it follows in the deſcent the progreſs of the uneven numbers 1, 3, 5, 7, the parts of the diameter *a f*, *g h*, *h k*, *k n*, will be as the ſame numbers 1, 3, 5, 7: therefore, as we have obſerved already, the quarters of the ordinates will be between themſelves, as the parts of the diameter intercepted by thoſe ordinates; and conſequently the bullet will very near deſcribe a parabola. For heavy bodies do not fall perhaps, exactly according to the progreſs of the uneven numbers; and the air beſides oppoſing the horizontal motion, hinders thoſe heavy bodies from following the natural ſeries of the numbers, by that horizontal motion; but the difference is not ſenſible in ſmaller diſtances. It does not ſeem foreign to our purpoſe to obſerve here, that bodies thrown to an angle of 55 degrees deſcribe a very great parabola.

For if a bullet be thrown upwards, and according to a perpendicular line, ſo as to form with the horizontal line a right angle, or of 90 degrees, it will fall through the ſame line.

But if it follows a line nearer to the horizontal, and form with it a leſs acute angle, it will fall ſooner by its weight.

Therefore to ſend it very far, and that it may deſcribe a very great parabola, a middle line muſt be choſen between the horizontal and perpendicular, *viz.* which ſhould form with the horizontal, a ſemi-right angle, or of 45 degrees.

For that reaſon, the more or leſs the line, according to which the projection is made, will be inclined to the horizon, one will be capable to judge into what place the bullets exploded will fall. For if above and beyond the forty-fifth degree of elevation, be taken equi-diſtant arches, *viz.* 40 and 50, the bullet will always fall in the ſame place of the horizon. But the parabola deſcribed by a bullet exploded according to 50 degrees of elevation, will be higher; and that according to 40 degrees of elevation, lower: though both will have the ſame amplitude, *i. e.* the bullet will arrive at the ſame point of the horizon.

If I be aſked, which is the cauſe of the progreſs of the motion of heavy bodies, by uneven numbers? I anſwer, that as that progreſs is not obſerved with much accuracy, it is very difficult to aſſign the cauſe thereof. Though that aſſigned by *Galileo*, and his diſciples, ſhew a great ſtrength of imagination. Let's ſuppoſe, ſay they, that a heavy body deſcends ſo as to accompliſh the firſt time, or within a ſecond, an hexaped; if when it began to be moved, it had had that velocity it acquired after the firſt time, it had run double the ſpace, *viz.* two hexapedes. Therefore in the ſecond time, by the force of that impetus it has acquired, and which it retains, it will run two hexapedes, and another, beſides, by its own gravity; ſo that it will run three hexapedes. Likewiſe the third time it will run, by the force it has acquired, not two hexapedes only, but four; to which if one be added, which it acquires by its own gravity, you'll have five hexapedes, which it will have to run in that time. There is the ſame ratio of increaſe in all the ſubſequent times; whereby they pretend that the motion of heavy bodies is to be

accelerated according to the progreſs of uneven numbers.

Theſe they commonly demonſtrate, *Fig.* 33. in which the line A B is ſaid to repreſent the times, *viz.* A 1, 12, 23, 3 B: and the lines 11, 22, 33, B C repreſent the velocities acquired to each time. And the ſpace over-run in the ſecond time which is exhibited by the three triangles contained between 11 and 22, is triple that which is run the firſt time, and which is repreſented by the ſingle triangle A 11. Likewiſe the ſpace run through in the third time, and expreſſed by the triangles contained with 22 and 33, is the quintuple of the ſame firſt A 11, *&c.* if the heavy body at the beginning of its motion had had that velocity, which it acquired at the end, it ſhould have run double the ſpace: which is expreſſed by the triangle A B C D, whereof the triangle A B C is but one half. But all theſe things are only ſhadowed with figures, but not demonſtrated.

MEDICINE.

MEDICINE is the art, which treats of the means of *preſerving health*, when preſent; and of *reſtoring* it, when loſt.

If we look back to the *origin* of the art of *medicine*, we ſhall find its firſt foundations to be owing to mere chance, unforeſeen events, and natural inſtinct: in the early ages, the ſick were placed in croſs-ways, and other public places, to receive the advice of thoſe paſſengers, who knew an efficacious remedy ſuitable to their diſorder. And the better to preſerve the memory of a remarkable cure, both the diſeaſe and the remedy were engraved on pillars, or written on the walls of temples, that patients in the like caſes might have recourſe to them for inſtruction and relief. Thus what mere accident had diſcovered, was regiſtered in theſe *chronicles of health*.

This art aroſe from repeated trials and long experience, which gave an inſight into the virtues of herbs and plants, metals and minerals.

As to the part, which reaſon has acted in the improvement of *medicine*, it ſeems to have conſiſted in obſerving, 1. That diſeaſes attended with particular circumſtances, called *ſymptoms*, were ſometimes cured without the aſſiſtance of art, by ſpontaneous evacuations, as *hæmorrhages*, *diarrhœas*, *vomitings*, or *ſweats*: whence bleeding, purges, and vomits took their riſe. 2. That the patients were often relieved, by the *breaking out* of various tumours; whence aroſe the application of *topical* remedies. And, indeed, it is the beſt method of improving *phyſic*, to obſerve carefully what means nature, unaſſiſted by art, employs to free the conſtitution from diſtempers; ſince many important hints may be thence taken, for the relief of other patients under the like circumſtances.

Let us now ſay ſomething of the regular method of ſtudying this art. And firſt, with *Boerhaave*, let us imagine the young ſtudent laying the foundation of his art in the contemplation of *geometrical* figures, bodies, weights, meaſures, velocity, the fabric of, and the power of acting upon other bodies thence ariſing. While he employs his thoughts about theſe matters, he is likewiſe taught a juſt method of reaſoning; after which he may proceed to inform himſelf of the properties of fluidity, elaſticity, tenuity, weight, and tenacity of liquids, from *hydroſtatics*.

His reaſon being by this time much improved, he next applies to ſtudy the forces of fluids upon machines, and of theſe upon fluids; and to demonſtrate them by *mathematics*, confirm them by *hydroſtatics*, and illuſtrate them by chemical experiments; at the ſame time entertaining himſelf with ſpeculations on the nature of fire, water, air, ſalts, and other homogenous bodies.

Having laid this foundation, his next buſineſs is to apply himſelf to the ſtudy of *Anatomy*, in order to obtain a clear idea of the human fabric. To this he joins the knowledge of the vital fluids, and examines them with the aſſiſtance of *anatomy*, *chemiſtry*, *hydroſtatics*, and even of the microſcope; and ſo now you ſee him qualified for writing a theory of health, and inveſtigating the cauſes of diſeaſes. Now behold him buſied in furniſhing himſelf with medicinal obſervations, from all quarters, ſometimes he diſſects the dead bodies of perſons, whoſe diſeaſes he had obſerved; at other times, he marks the ſymptoms of ſickneſs procured by art in brutes; and at length collecting together all the effects of diſeaſes, with their remedies, whether learned from his own experience, or found in the beſt authors, he digeſts, conſiders, and compares them with thoſe which are demonſtrated by theory.

This, he tells us, is the method which he took himſelf, and which he recommended to his pupils, in order to gain a thorough knowledge of *medicine*.

If, then, he would advance the healing art, he ought to collect a ſelect treaſure of *practical* obſervations, reſt ſatisfied with a few but well choſen medicines;

medicines; be thoroughly acquainted with their virtues and efficacy in different conſtitutions and diſeaſes; deſpiſe the cumberſome load of recipes with which practical writers of an inferior rank abound, reject the ſo much extolled medicines of the *chemiſts*, and attempt the relief of patients by a proper diet and exerciſe, and ſuch medicines, as obſervation and ſound philoſophy recommend: for to the improvement of *anatomy* and *natural philoſophy* is much of the ſucceſs of *phyſic* to be attributed.

The knowledge of *medicines*, or ſuitable remedies are alſo highly neceſſary to phyſicians; who, in order to moderate the *impetus* in acute diſorders, make evacuations, blunt acrimony, dilute too thick fluids, condenſe thoſe that are too thin, brace up too lax parts, and relax ſuch as are too much conſtricted; they alſo drive the humours to parts where they will be leaſt prejudicial, upon occaſion mitigate pain, and in langours, uſe ſtimulating medicines. Wine, vinegar, barley, nitre, honey, rhubarb, opium, and other ſimples, are found both ſafe and powerful medicines. *Sydenham* tells us, that all manner of diſeaſes may be cured by bleeding, purging, with a ſubſequent opiate, and proper regimen. In chronical caſes, mineral waters, ſalts, diaphoretics, ſoap, mercury, ſteel, with a few vegetables, and proper exerciſe, will generally effect the cure.

As to the *drugs* recommended by the *antients*, adds *Boerhaave*, we are, and always ſhall be, ignorant of them, unleſs perhaps a few; ſince they contented themſelves with giving the virtues; omitting the deſcription of plants, as things well known. The *moderns*, on the other hand, have been accurate in the deſcriptive part, but have given us very little concerning the virtues of plants, except what they tranſcribed from the antients, and this upon an uncertain ſuppoſition of the plants being the ſame. To conclude, what is there in the moſt elaborate preparation, that is worth half the pains taken about it? *mercury*, *opium*, the *peruvian* bark, and other ſimples, with fire and water, are acknowledged as the ſureſt remedies by the ableſt maſters of the art; and theſe are found to be more efficacious in that crude ſtate, in which bountiful nature has imparted them to us, than after the moſt operoſe and artificial preparations. We can deſpair of nothing, while we follow ſimplicity; but the event of intricate labour is fallacious.

Phyſick or *medicine* is divided into *five principal* branches; the *firſt* conſiders the human body as curable, and is called *phyſiology*; the objects of this part are called *res naturales*. The *ſecond* conſiders the diſeaſes, their differences, cauſes, and effects: as it conſiders the cauſes in general, it is called *pathology*, *atiology* when it penetrates into their cauſes; *noſology* when it examines their differences: and *ſymptomatology*, when it explains their effects. The objects of this part, are called *res præternaturales*, or beyond nature.

The *third* branch conſiders the ſigns or ſymptoms, and how to form a juſt prognoſtick, or judgment from them; with regard either to the adminiſtration of proper remedies, or to pronounce in the affirmative, on the recovery, or the dangerous ſtate the patient is in: this is called *ſemeiotica*; and its objects are natural, non-natural, and preter-natural.

The *fourth* branch conſiders the remedies, and their uſe, whereby life may be preſerved, whence it is called *hygieine*. Its objects are what we ſtrictly call non-natural.

Laſtly, the *fifth* furniſhes the *materia medica*, its preparation and manner of exhibition, ſo as to reſtore health, and remove diſeaſes, and is called *theraupeutica*, containing the *diætetica*, *pharmaceutica*, *chirurgica*, and *jatrica*.

I'll begin by an accurate explication of the firſt branch of *medicine*, viz. *phyſiology*; ſince no body can pretend to be a good phyſician, without as perfect a knowledge as poſſible can be acquired of the œconomy of the human body, called *animal œconomy*; which œconomy conſiſts chiefly in explaining the parts thereof, their ſtructure and uſe; but as I have already given that explication at large in my treatiſe of *Anatomy*, under the latter *A*; I'll content myſelf with examining carefully in this place, the humours of the human body, ſince they are the ſeat of all our diſeaſes: and in proportion as they are predominant over one another, are the occaſion of the difference of temperaments or conſtitutions.

HUMOUR is applied in medicine to any juice, or fluid part of the body, as the *chyle*, *blood*, *fat*, *ſerum*, *lymph*, *ſpirits*, *bile*, *ſeed*, *ſalival*, and *pancreatick juices*, &c.

The four humours ſo much talked of by the *antient* phyſicians, are four liquid ſubſtances, which they ſuppoſe to moiſten the whole body of all animals, and to be the cauſe of the divers temperaments thereof. Thoſe are the *blood*, *phlegm*, *bile*, and *melancholy*, or *atra bilis*.

The *modern* phyſicians chuſe rather to diſtinguiſh them into *nutritions*, called alſo *elementary*; as *chyle* and *blood*; thoſe *ſeparated* from the blood, as *bile*, *ſaliva*, *urine*, &c. and thoſe *return'd* into blood.

Humours again are diſtinguiſhed into natural, or ſalutary, or morbid and corrupted. To the former belong all the juices ordinarily ſecreted for the uſes of the body.

To the latter belong thoſe compound humours, which thickning and growing putrid, cauſe tumors, abſceſſes, obſtructions, and moſt diſeaſes. Of the former *humours* I have ſpoken at large, under *Anatomy*; and of the latter I'll ſpeak in this place, diſtinguiſhing them by various names, viz. *malignant*, *aduſt*, *acrimonious*, *corroſive*, *crude*, *peccant*, &c. *humours*; as more proper for my preſent ſubject.

A *malignant humour* is that, which in a diſeaſe renders it more than ordinarily dangerous and difficult of cure, as in epidemical and infectious fevers, attended with ſpots and eruptions of various kinds.

Aduſt humour is that, which by long heat becomes of a hot and fiery nature; ſuch is choler ſuppoſed to be. Melancholy is uſually conſidered as black and aduſt bile. Blood is ſaid to be aduſt when by reaſon of ſome extraordinary heat, its more ſubtile parts are moſt evaporated, leaving the groſſer with all the impurities therein, half torrified, as it were.

Acrimonious humour is that, which diſſolves other humours in the body.

Acid humour is that, which coagulates the animal fluids, and produces obſtructions with all their train of conſequences.

Corroſive humour is that, which carries devaſtation wherever it paſſes, even breaking and lacerating the texture of the fibres, *&c.*

Crude humours are thoſe, which want that preparation and elaboration, which they ordinarily receive from a thorough digeſtion.

Peccant humours, are thoſe which offend either in quantity or qualities, *i. e.* when they are either morbid or in too great abundance, which humours are the cauſe of moſt diſeaſes.

This brings us to the ſecond branch of medicine, called *pathology*, and which conſiders *diſeaſes* in general.

Diſeaſe, in *Medicine*, is that ſtate of a living body, wherein the principal functions thereof, are either obſtructed, impaired, or ſome of them entirely ſuſpended.

An ingenious author holds the eſſence of a diſeaſe to conſiſt in a want of that equilibrium between the ſolid and fluid parts, which is neceſſary to the maintenance of health: others add, that all diſeaſes ariſe either from too lax or too ſtrict a tenſion of the fibres.

Some diſeaſes only impair the uſe of the part, as the *opthalmia*, *gout*, &c. others deſtroy it entirely, as the *gutta ſerena*, *palſy*, &c. ſome affect the whole body, as the *fever*, *apoplexy*, *epilepſy*, &c. others only impair a part, as the *Aſthma*, *colick*, *dropſy*, &c. ſome only affect the body, as the *gout*; others diſturb the mind, as *melancholy*, *delirium*, *vertigoes*, &c. others affect both the body and mind, as the *mania*, *phrenzy*, &c.

As the actions or conditions of the body, ſo alſo the diſeaſes or effects thereof may be reduced to three general heads, *viz.* 1. Diſeaſes of the *ſolid parts*.—2. Thoſe of the *fluid parts*.—And 3. Diſeaſes compounded of both.

A popular ſyllabus of diſeaſes may be given, as follows:—the *ſolid parts*, i. e. the bones and fleſh, may be diſordered five ways, *viz.* rendered turgid by tumors, cut with wounds, corroded by ulcers or caries's; removed out of their places, as in hernia's, prolapſus's, and diſlocations; or diſcontinued by fractures or contuſions.

Diſeaſes of the *fluids*, are either in the maſs of the blood or the ſpirits:—thoſe of the blood are reducible to two kinds, *viz.* thoſe that thicken or inſpiſſate, or, which amounts to the ſame, retard its motions; and thoſe which attenuate and diſſolve, and conſequently accelerate it.

To this latter kind belong *fevers*, and feveriſh affections alone: all other diſeaſes of the blood belong to the former.

In too thick a ſtate of the blood, its principles are too craſs, and its molecules too big, whence a lentor, lazy motion, and even ſtoppage, particularly in the ſinuous paſſages of the glands: hence *obſtructions*, *inflammations*, *ſcirrhus's*, *ſarcoma's*, *veruca*, *puſtules*, *ædematæ*, *impetigines*, and other *tumors* and *congeſtions*, both in the viſcera, and habit of the body: and hence again, *drowſineſs*, *melancholy*, *hypochondriacal affections*, &c. if this thick blood be too much replete with ſharp acrid ſalts, it will deſtroy the texture of the parts and break out in ulcers, as in *phthiſical*, *ſcrophulous*, *ſcorbutick*, and *venereal diſeaſes*, *gangrenes*, *carbo's*, *cancers*, and other *eroſive tumors*, according to the quality and degree of ſaltneſs and acrimony; and from the ſame ſource ariſes *cephalalgia's*, *cardialgia's*, *colicks*, *gout*, *rheumatiſm*, *pleuriſies*, &c. which by abraiding the ſolid ſubſtance frequently emaciate the body.

The diſeaſes of the *animal ſpirits* ariſe either, 1. From an intermiſſion or retardation of their motion; or a diminution of their quantity; or,—2. From a diſorder in their quality.

To the firſt claſs are reduced the *catalepſis*, *apoplexy*, *comacarus*, *palſy*, *ſtupor*, *tremor*, &c. To *the ſecond*, belong the *mania*, *phrenzy*, *delirium*, *fooliſhneſs*, *melancholy*, *vertigo*, *ſpaſms*, *epilepſy*, *hyſterick affections*, *horror*, &c. Add, that as all diſeaſes of the blood ariſe from external cauſes, *viz.* ſome one or more of the non-naturals, as food, air, evacuation,

evacuation, &c. ſo thoſe of the ſpirits generally proceed from diſorders of the blood.

Laſtly, the diſeaſes of the *fluids*, whether thoſe in the blood or ſpirits, are ſeldom confined long thereto; but preſently come to diſturb and impede ſome of the functions of the ſolid parts, and at laſt corrupt the ſubſtance of the ſolids themſelves. Hence compound or complicated diſeaſes, which are infinitely various.

Boerhaave divides diſeaſes into thoſe of the *ſolids* and *fluids*.

Diſeaſes of the *ſolids* he conſiders either of the *ſimple* and *ſimilar* parts, or of the *organical*.

Similar diſeaſes are, 1. Thoſe of the leaſt and ſmalleſt *fibres*, which are reducible to too great tenſion and laxneſs, too great ſtrength or weakneſs, and a ſolution of their continuity.

2. Thoſe of the *membranes*, which being only aſſemblages of the fibres mentioned, are ſubject to the ſame diſorders.

3. Thoſe of the laſt and ſmalleſt *canals*, which are formed of ſuch *membranes*.

4. Of the *membranes* compoſed of ſuch canals.

5. Of *canals* compoſed of ſuch membranes, which are all the greater veſſels of the body.

6. Of the *ſolid parts*, which are compoſed of canals compreſſed, and grown together ſo as to be void of humour to diſtend them; or canals growing into a conſiſtent part, the humour hardening together with the veſſel that contain it.

Laſtly, ſuppoſing theſe parts all ſound, diſeaſes may befal them with reſpect to their ſtructure, from a vice, or vicious application of the matter of nutrition.

Organical diſeaſes.—An organical part conſiſting of the ſeveral ſimple parts above mentioned, and fitted to perform any office by means of ſome humour contained in it; may be conſidered, either in itſelf, as a ſolid part, or with reſpect to the humour it contains: in the firſt view, *organical diſeaſes* are reducible to four claſſes.

1. Diſorders in the figure and circumſtances thereof; as *roughneſs*, *ſolidity*, *cavity*, &c.—To this belongs *anaſtomoſis*, when one veſſel opens into another; the *diapedeſis*, when a rupture is made; *diareſis*, when a breach is occaſioned by corroſion; the *emphraſis*, which is the total obſtruction of the cavity, by a vicious grumous matter; the Στενοχωρια, or narrowneſs of the paſſage; the Θλιψις, or compreſſion of the ſides of the cavity; Συμφυσις, when the ſides are quite cloſed up; and Συνιζησις, when the veſſel is ſo emptied that the ſides falling together, the cavity is loſt.

2. In the number, where it is either deficient or redundant: but the parts ſeldom err in this reſpect, ſo as to occaſion a *diſeaſe*.

3. In the magnitude; to which belong nodes, exoſtoſes, and callus's.

4. In the ſituation and connexion; as when the ligaments are too long, or too ſhort, when broke or depraved; alſo *diſtortions*, *laxations*, *ſubluxations*, *herniæ*, or *ruptures* in the groin, ſcrotum, bladder; *procidentiæ*, of the womb, bladder, and rectum; diſorders of the tendons and muſcles, particularly their flying out of their places; the relaxation or rupture of the membranous ligament that ſhould retain them.

Laſtly, there is a *diſeaſe*, common both to *ſimilar* and *organical* parts, called *ſolution of continuity*; wherein their natural cohefion is ſeparated: as by a wound or other cauſe.

If this happens to a ſimple ſimilar part of the body, it is called ſimply *ſolutio continui*.—If to a compound or organical part, it acquires a particular denomination, from the nature of the part, the difference of the cauſe, or the manner of application; as a *wound*, *rupture*, *fracture*, *puncture*, *fiſſure*, *contuſion*, *ulcer*, *corroſion*, *dilaceration*, *exfoliation*, *caries*, &c. all which are explained in the treatiſe of *Chirurgery*.

Diſeaſes of fluids, conſidering thoſe fluids ſimply, and in themſelves, may be reduced to diſorders in reſpect of quantity or quality; but conſidering them as contained in ſolids, they may err to in place and proportion.

As to the *firſt*, ſuch an abundance of the humours, as diſturb the animal functions, is called a *plethora*.

PLETHORA is chiefly underſtood of the blood, tho' ſometimes of the other humours.

The *plethora* is the conſequence of a good chylification, ſanguification, &c. attended with a too ſparing diſcharge by perſpiration.

The *plethora* is chiefly produced in a body, whoſe organs of digeſtion are ſtrong, blood-veſſels lax, diet full of good juice, temperament ſanguine, mind at eaſe and indolent, of a middle age, and in a moiſt air.—It renders heat and motion intolerable; ſtretches the great veſſels, and compreſſes the ſmaller: and hence ſtiffneſs and heavineſs, and on the leaſt occaſion ruptures in the veſſels, ſuffocation, &c. *Diſeaſes* from the defect of humours, we ſcarce know of any.

As to the *ſecond*, ſuch quality of the humours as diſturb the animal functions is called *cacochimia*. Now this is either in the fluids conſidered in themſelves, their own parts, and compoſition; or conſidered as they concur towards conſtituting ſome part of the body.

Goræus gives the name *cacochimia*, to the abundance, or exceſs of any ill humour; whether it be bile,

bile, pituita, *&c.* provided there be only one that thus offends in quantity.

If the morbid quality be considered in the particles of the humour, it must either consist in an augmentation of bulk, whence the *emphraxis*, *atrophy*, *symphysis*, and *synerefis*; or in the diminution thereof, as in the *diapnoe* and *ceneangeia*; or in an increase of solidity, whence too great an attenuation; or a decay thereof; whence a *lentor*, *stagnation*, and *cohesion*; or in the figure, as when of spherical it become angular, and consequently, with respect to the part it is applied to, sharp; whence *acrimonies*, both acid, alkaline, muriatick, ammoniack, saponaceous, vitriolick, *&c.* and oleosities; or in rigidity and flexibility; or in elasticity; or in cohesion, and divisibility.

Again, all the juices being considered together, the principal disorders they are subject to, are too great fluidity or tenacity; too much velocity in their vessels, or too little.

Lastly, considering the fluids are contained in the solids, there arises divers *diseases*, merely from their changing of place; which may be reduced to two classes, *viz.*—The grosser humours intruding themselves into the finer canals; and the humours extravasating, or getting out among the solid parts; whence *inflammations aneurisma's*, *varices*, *echymoses*, *œdema's*, *pustules*, *dropsy*, *spongeous membranes* of the head, breast, abdomen, and uterus; and *emphysema's*; all mentioned at large in the treatise of *Chirurgery*.

Add, that the humours collected and stagnating among the parts, grow putrid, purulent, ichorous, erosive, and sharp; and thus destroy the tender stamina of solids; whence *sinus's*, *fistula's*, *ulcers*, *gangrenes*, *sphacelus's*, *cancers*.

Those are the prime differences of the diseases of the body, and from these arise most of the rest: so that they may be regarded, not only as diseases, but as the causes of diseases.

There is another division of *diseases* in use among Physicians, taken from certain external accidents, and are distinguished,—1. With respect to their cause, into *idiopathy*, *sympathy*, *protopathy*, *deutropathy*, *hereditary*, *connate*, and *acquired*.

Idiopathy is a disease, or indisposition, peculiar to some member, or part of the body; not caused by any other *disease*, or preceding affection; nor having any dependance on the rest of the body. Thus a cataract in the eye in an *idiopathy*; and epilepsy is either *idiopathick* or *symphatick*; *idiopathick*, when it happens purely thro' some fault in the brain; *sympathick*, when it is preceded by some other disorder.

Sympathy is an indisposition befalling one part of the body, through the defect or disorder of another; whether it be from the affluence of some humour, or vapour sent from elsewhere; or from the want of the influence of some matter necessary to its action.

Hereditary are *diseases* capable of being transmitted, by blood, from father to son. The *gout*, *king's evil*, *madness*, &c are *hereditary diseases*, i. e. are transmitted from the parents in the stamen, or first rudiments of the fætus; and such, probably, is the origin of numerous other chronick *diseases*.

2. With respect to their subject, into diseases of old age, children, adults, men, women, maids, pregnant, parturient; endemical, epidemical, *&c.*

Endemical disease is that which affects many people together, in the same country; as proceeding from some cause peculiar to the country where it reigns:—Such are the *scurvy* in the northern climates; *intermitting fevers* and *colicks*, in marshy places, *&c.*

Epidemical disease is a general or spreading disorder, as the plague, arising from some corruption, or malignity of the air, which seizes a great number of people in a little time.

3. With respect to duration, into *most acute*, which terminate in four days; *acute*, in twenty; and *chronical*, which are all those of longer continuance.

4. With respect to seasons, into *vernal*, *autumnal*, *continual* and *intermitting*.

5. With respect to their effects, into *benign*, *malignant*, *curable*, *incurable*, *mortal*, and *contagious*.

And, 6. With respect to their state, into *beginning*, *progress*, *state*, *declension*, and *end*.

The entering into a particular examen of the cause of a particular disease, is called *æthiology*. To examine their differences, *nosology*; and to explain their effects, *symptomatology*; all which I'll treat of in the examen of the different maladies of the human body: and this leads me into the third branch of my division of *Medicine*.

The third branch of *Physick* or *Medicine*, called *semeiotice*, or *semeiotica*, is that part which considers the signs or indications of health and diseases.

Indications, in *Physick*, signnifies the pointing out, or discovering what is fit to be done, and what means applied in any case from the knowledge of the nature of the disease, and the virtues of medicines.

There are four kinds of *indications*, viz. *preservative*, *curative*, *palliative*, and *vital*.

A *preservative indication* is that, which directs how to cut off the cause of an approaching disease.

A *curative indication* is that, which ſhews how to remove a diſeaſe actually formed.

A *palliative indication* directs how to leſſen the effects of a diſeaſe, or take off ſome of its ſymptoms, before it can be wholly removed.

And *vital indication* relates to the ſtrength of the body, which muſt be narrowly inquired into, before any remedy, particularly a violent one, can be adminiſter'd with ſafety; a phyſician ſhould make it his whole ſtudy to examine carefully all the *indications* mentioned.

1. The *preſervative indication*, by preſcribing in time to his patient, remedies which he thinks the moſt ſpecifick to prevent a malady, which he ſees him threaten'd with: and not ſuffer a ſlight indiſpoſition to degenerate perhaps into a dangerous malady.

2. If the diſeaſe be actually formed, then the *curative indication* is to be minded, by preſcribing thoſe remedies, which he knows to be the moſt ſpecifick, for the ſpeedy cure of ſuch a malady, without loading the ſtomach with poiſonous medicines.

3. The *palliative indication* is of very great conſequence, ſince there are ſometimes ſymptoms much more dangerous than the malady itſelf, and which neglected, even for ſo ſhort a time, put the patient in very great danger; and others, which, if not taken off, will render the diſeaſe rebellious to all remedies; therefore this axiom is not true, in all circumſtances, *ſublata cauſa tollitur effectus.*

4. As to *vital indications*, though the remedy is well appropriated to the malady, and produces the effect expected from it; if it operates with too much violence, it may weaken the patient to ſuch a degree, as to reduce him into a worſe condition, than he was while afflicted with the diſeaſe he has been cured of,

The *counter indications* contribute alſo very much towards avoiding thoſe dangerous inconveniencies. For a *counter* or *contra indication*, is an *indication* which forbids that to be done which the main ſcope of a diſeaſe points out. Suppoſe, *e. gr.* in the cure of a diſeaſe, a vomit were judged proper, if the patient be ſubject to a vomiting of blood, or has an extremely weak ſtomach, it is a ſufficient *contra-indication*, as to its exhibition: for if he be ſubject to a vomiting of blood, the efforts made in vomiting may cauſe a violent hæmorrhage; and if his ſtomach be very weak, vomiting may occaſion a ſyncope, or other dangerous accidents. The ſame is to be ſaid of thoſe who are ſuſpected to have abſceſſes in the capacity of the breaſt, who are not to take vomits, for fear they ſhould be ſuffocated, during the efforts, by the abſceſs breaking at that time.

Next to *indications*, and *contra-indications*, are *ſigns*, which in medicine denote ſome appearance in the body, diſtinguiſhable by the ſenſes; whence, by juſt reaſoning, is inferred the preſence, nature, ſtate, of health, a diſeaſe, or death.

Thoſe *ſigns* which denote the preſent condition of a body, whether ſick or well, dying or the like, are called *diagnoſtick ſigns*. Thoſe which foretel the future ſtate thereof are called *prognoſtick ſigns*.

As all *ſigns* are effects produced by the cauſe of the diſeaſe, the diſeaſe itſelf, and the ſymptoms; they uſually note the preſent condition of the matter which firſt produced the diſeaſe, and even of that produced by the diſeaſe: on which footing *ſigns* are all reducible to theſe three claſes, *viz.*—*Signs.* 1. Of crudity and coction of the diſeaſe. 2. Of its event, whether in health, ſickneſs, or death. 3. And of its ſecretion and excretion; which laſt ſigns are called *critical* ones.

CRUDITY, ſometimes denotes that ſtate of a diſeaſe, wherein the morbifick matter is of ſuch bulk, figure, coheſion, mobility, or inactivity, as creates or increaſes the diſeaſe.

The *crudity* is diſcovered,—1. From the diſeaſe continuing its degree of ſtrength, or increaſing.—2. From a continual increaſe of ſymptoms.—3. From a diſorderly exerciſe of the functions.—4. But chiefly from a fault in the quantity or quality of the humours; both thoſe ſtill circulating, and thoſe ſecreted; as of *ſweat*, *tears*, *mucus* of the noſe, *ſaliva*, *ſputum*, the *bile*, *urine*, *ichor*, *pus*, *blood*, *menſes*, *lochia*, *milk*, *aphthæ*, &c.

The ſtate of the diſeaſe wherein the crude matter is changed, and rendered leſs peccant and laudable, is called *digeſtion*, *concoction*, or *maturation*.

DIGESTION is that ſtate of a diſeaſe wherein the morbifick matter is ſo changed in bulk, figure, coheſion, mobility, *&c.* by the uſe of proper medicine, or even by the force of nature, as to be leſs noxious, and hurtful, and conſequently to abate the violence of the diſtemper. The matter of the diſeaſe ſo far *digeſted*, as to become next a kin to ſalubrious or healthy matter, is ſaid to be reſolved; which is done either by the natural ſtrength of the patient, or of its own accord, or by the application of remedies; whereby its bulk, figure, coheſion, *&c.* are ſo far changed, as that is ceaſes to be morbid, and becomes laudable.

This, *Boerhaave* obſerves, is of all others the moſt perfect cure, where it is effected without any evacuation; as ſuppoſing the matter favourable, the conſtitution excellent, and the medicines good.

Critical

Critical signs are certain signs usually arising in the course of acute diseases, as fevers, small-pox, *&c.* which indicate the patient's state, and determine him either to recover or grow worse.

The *crises* have been frequently observed to happen on the seventh, fourteenth, or twentieth day.

As to the *theory of critical days*, it may be observed, that the connection of any morbifick matter and the humour to be secerned, is nothing else but a change thereof into such a due magnitude or smallness, as it may be carried by the circulating blood along the canals, and excerned by vessels destined for that purpose. But if the morbifick matter cannot be reduced to such a magnitude or smallness as may correspond to the orifices of the secretary vessels; then either an abscess or hæmorrhage will follow, if a *crisis* be begun; for which reason abscesses, *&c.* are accounted less *perfect crisis*. But that the morbifick matter may be reduced to a due magnitude or smallness, and its wish'd-for discharge take place, there is required a considerable time, if the quantity of matter be large; that is, if the distemper be great and severe: and since there are a great many causes, and those very constant, which may occasion the blood and offending humours therein, to be of a different fluidity in the inhabitants of different climates; it is impossible but that different spaces of time should be required for the finishing concoction: which make it impossible to determine the *critical days* in one climate, from what they are found to be in another.

Among all other signs, a judicious physician must mind, in a particular manner, the *critical* and *prognostical* ones. The *critical*, because though a disease declares itself favourably, by some signs of a good crisis; if those signs be not minded, the *crisis* may be either neglected, and thereby frustrated of the good effects it would otherwise have produced; if, *e. gr.* by a sweat, in suffering the patient to cool himself, either outwardly, by thrusting his arms out of his bed, *&c.* or inwardly, by taking some cooling draughts, *&c.*—Or prevented, by the administring of some remedy, to procure the evacuation of the morbifick matter, otherwise than nature had determined itself to do it; whereby being disturbed in its salutary operations, the patient is exposed to the imminent danger of losing his life. The *prognostick signs* are very near of the some consequence; since it is on them that the Physician must found his judgment of the recovery or death of his patient; in which he must not shew too much precipitation, inclining rather to uncertainty, while he sees some probable signs of a recovery, let them be ever so small or glimmering, than pronounce affirmatively on the death.

Symptom is ordinarily confounded with *sign*, and defined an appearance, or assemblage of appearances, in a disease, which shew its nature and quality; and from which one may judge of the event thereof.

In which sense a *delirium* is held a symptom of a *fever*.—*Pain*, *wakening*, *drowsiness*, *convulsions*, *suppression of urine*, *difficulty of breathing* and *swallowing*; *coughs*, *distastes*, *nausea's*, *thirst*, *swoonings*, *faintings*, *looseness*, *costiveness*, *dryness*, and *blackness of tongue*, are the principal symptoms of diseases.

Boerhaave gives another notion of symptoms: every preternatural thing arising from a disease, has its cause, in such manner, however, as that it may be distinguished from the disease itself, and from its next cause, is properly a *symptom* of the disease.

If it arise, after the same manner, from the cause of the disease, it is called a *symptom* of the cause.

If it arise from some former *symptom*, as its cause, it is properly called a *symptom* of a *symptom*.

Whatever happens to a disease from any other causes than those mentioned, is properly called an *epigennema*.

Hence it appears, that the *symptoms* above recited, are really diseases themselves. They are various as to number, effect, *&c.* though, after the antients, they may be conveniently enough reduced to faults in the functions, excretions, and retentions.

Under the first come all diminutions, abolitions, increases, and depravations of animal actions, particularly with regard to hunger and thirst, sleeping and waking.

Under the second come *nausea's*, *vomitings*, *lienteries*, *cæliac affections*, *diarrhœa's*, *dysenteries*, *illiack passions*, &c.

Under the third come the *jaundice*, *stone*, *dropsy*, *fever*, *ischuria*, *strangury*, *asthma*, *catarrhea*, &c.

Let us now consider the fourth branch of my division of *Medicine*, called *Hygieine*.

Hygieine may be divided into three parts, *viz.* *Prophylactice*, which forces and prevents diseases.—*Synteritice*, employed in preserving health.—And *Analeptice*, whose office is to cure diseases.

But before I proceed further on this division, I must give the reader a notion of *remedies* or *medicines* in general.

Medicines, or *remedies*, or *medicaments*, denote any natural substances, applied to a human body, in order to answer some intention of cure.

Medicines are distinguished, with regard to the manner of application, into *internal* and *external*.

Internal medicines are those taken in at the mouth.

External

External or *topical medicines* are thoſe applied outwardly to any particular part.

With regard to their different manner of operation, *medicines* are diſtinguiſhed into *agglutinants*, *alterants*, *anaſtomachics*, *aſtringents*, *evacuents*, *incarnatives*, *ſpecificks*, &c.

A general idea of the manner wherein *medicines* operate on a human body, as explained by the ſect of mechanical phyſicians, may be conceived from what follows.

A few different ſorts of particles, variouſly combined, will produce great variety of fluids; ſome may have one ſort, ſome two, ſome three or more. If we ſuppoſe only five different ſorts of particles in the blood, and call them *a*, *b*, *c*, *d*, *e*; their ſeveral combinations, without varying the proportions in which they are mix'd, will be theſe following; but whether more or leſs need not be determined.

ab : *ac* : *ad* : *ae* :
bc : *bd* : *be* : *cd* :
ce : *de* : *abc* : *adc* :
abd : *abc* : *ace* : *adc* :
bdc : *bde* : *bec* : *dec* :
abcd : *abce* : *acde* : *abde* : *bcde* : *abcde*.

I muſt confeſs that this ſyſtem of combinations, adapted to the different manner of the operating of remedies, is a pretty diverting thing, eſpecially for thoſe which have ſome notion of Algebra: but I muſt confeſs alſo, that in my ſentiment, it has no other merit; and does not at all explain in an intelligible manner, that of operating of medicines; and there is ſcarce any appearance of truth in it, the whole ſyſtem or hypotheſis being founded in part on the falſe ſuppoſition, that purgatives penetrate as far as the ſubſtance of the blood, to ſeparate the humours which ſuperabound in it, in order for their ſecretion, which is falſe; for if *purgatives* were to enter the ſubſtance of the blood, they would prove more prejudicial than beneficial to it, for by the exceſſive fermentation they might excite in it, they would ſo diſunite the particles the whole maſs is compoſed of, as to occaſion diſeaſes much more dangerous than thoſe whereof the cure is attempted by their means; therefore *purgatives* operate no where elſe but in the primæ viæ; where by irritating the glands they meet with on their paſſage, they force them to contract themſelves with ſuch violence, as to ſecrete through their ſpongeous ſubſtance the humour they contain; and as there is no intermiſſion in the circulation of the blood, and in that circulation it is always unloading itſelf of the ſuperfluous humours, more or leſs, according to its faculty of ſecretion, which is increaſed or diminiſhed, in proportion to its greater or leſſer velocity, the glands are no ſooner empty but they are filled again; and as they are ſome time before they can recover their former ſtate and contract their pores, extremely dilated by the irritation, the ſecretion continues, more or leſs, according as the purgatives are more or leſs violent, and conſequently have made a greater or leſſer impreſſion on the membranes of the glands; and if the irritation has been exceſſive, the pores of the glands being exceſſively dilated every where, as well towards receiving the ſecretion of the blood, as towards ſecreting that ſecretion; the evacuation of the humours will conſequently be more copious, and continue longer, whereby one may very well account for the copiouſneſs of a ſalivation; for as the pores of the glands are extremely dilated by the continual rotation of the mercurial particles thro' them; when a too great quantity of thoſe particles is introduced into them, by means of a too copious friction, or inward adminiſtration of mercurial preparations, that rotation being more violent by a too great number of the mercurial particles crowding through the pores, they are ſo much dilated, that their contractive faculty is thereby almoſt entirely imbecillitated; ſo that the humours finding a more free paſſage that way than any where elſe, flow all thither in abundance, and with great impetuoſity.

As to *ſudorificks*, they certainly penetrate as far as into the ſubſtance of the blood; for as they are compoſed of more ſubtile particles than the purgatives, and thoſe particles leſs embaraſſed with viſcous and ramous ones, they are therefore eaſier volatilized in the ſtomach, and rendered capable thereby to penetrate the moſt exiguous pores of the ſubſtance of the chyle, which uſhers them along with it into the maſs of blood; and the greater is the number of thoſe particles it is loaded with, the more copious is the ſecretion of the humours, for if they be but in ſmall quantity, they only produce an inſenſible perſpiration, if otherwiſe they provoke ſweat. Their manner of operating in the blood is by rarefaction; but as though humours cannot be all equally well attenuated, ſome of them, eſpecially the phlegm, being of a too viſcous texture to be entirely rarefied, the coarſer particles thereof being too heavy to be uſhered through the pores, along with the volatile ones of the remedies, which the native heat keeps in a continual motion, they follow their own propenſity downwards, and are evacuated through the primæ viæ along with the urine; thoſe who have took a ſudorifick evacuating much more of that excrement immediately after the remedy has done operating, or even while it operates than they did before.

The *dieureticks* being compoſed of hooked, ſharp, and inciſive particles, faſten or entangle themſelves in the ramous texture of the phlegm, which they ſhake and lacerate, more or leſs, according as their motion is more or leſs accelerated by the native warmth, which laceration producing a more than ordinary heap of watery humour, that humour forces with impetuoſity through its natural paſſage, meeting with oppoſition from all other parts, whence enſues a greater evacuation of urine.

Now for the diviſion of *hygieine* into *prophylactice*, *ſynteritice*, and *analeptice*.

Prophylactice is that part of *Medicine*, which directs the preventing or preſerving from diſeaſes; which conſiſts, according to ſome, in taking remedies by way of precaution.

The principal preſervations, according to *Boerhaave*, are abſtinence, quiet, drinking of warm water; and after this a gentle and continued motion till the firſt appearance of ſweat; then a profuſe ſleeping, the body well covered.

By ſuch means, ſays he, groſs humours are dilated, the veſſels relaxed, and noxious matter excreted.—He adds, that the beſt defence againſt the force of external cold, is to leſſen the winter's cloathing late in the ſpring, and to encreaſe the ſummer's cloathing ſoon in autumn.

Dr. *Wenceſlaus Dobr. Zenſky de Nigro Ponte* gives us an univerſal *preſervative* againſt infection in all diſeaſes. Whoever, ſays he, in converſing with patients of any kind, would preſerve himſelf from infection, muſt, while he is within the ſphere of their effluvia, never ſwallow his ſpittle, but ſpit it out: for he conceives it to be the ſpittle that firſt imbibes the infection.

Syteritice relates to what is uſed to preſerve health; therefore there is no difference between it and *prophylactice*; for the ſame means which are uſed to prevent diſeaſes, are uſed to preſerve health.

Analeptice relates to remedies proper to reſtore the body, when waſted or emaciated, either by the continuance of a diſeaſe, or the want of food; which remedies are called *reſtoratives*.

The *medicines* that come under this denomination, are of an emollient ſoftening nature, but nutritive withal, and are rather adminiſtered to repair the waſtes of the conſtitution, than to alter and rectify its diſorders.

Such are ſuppoſed to be the leaves of *white and black maiden-hair*, *black hellebore*, *rocket*, *eruca*, *ſcabious*, *colts-foot*, *bohea tea*, *chick peas*, *hops*, *chocolate*, *piſtachio nuts*, *balſam of Tolu*, *bdellium*, *benzoin*, *ſtorax*, *eryngo*, *iris*, *ſatyrion*, generous wines, mutton-juice, and a juice extracted from beef, and the trunks of vipers, in balneo mariæ, to take two or three ſpoonfuls of it twice or thrice a day.

To reduce all this theory into practice, I'll divide the human body into three parts, *viz.* the *head*, *breaſt*, and *abdomen*; and treat of all the different diſeaſes each part is ſubject to; of their cauſes, ſymptoms, prognoſticks, and the manner of curing them. Beginning by the diſeaſes of the head.

Diseases *of the* Head. The Head, is ſubject ro ſeveral very dangerous diſeaſes, *viz.* to the *apoplexy*, *carus*, *coma*, *epilepſy*, *lethargy*, *mania*, *madneſs*, *palſy*, *phrenzy*, *ſyncope*, &c.

The Apoplexy, is a ſudden privation of all the ſenſes, and all the ſenſible motions of the body, except thoſe of the heart and lungs, attended with a great depravation or ſuſpenſion of the principal faculties of the ſoul.

Hippocrates diſtinguiſhes two kinds of *apoplexies*, the one *ſtrong*, the other *weak*; only differing in the greater or leſs difficulty of reſpiration and pulſation. In the *former* the pulſe and breath ſeem entirely ſtopped. In the *latter* there are conſiderable remains of them.

The more modern authors diſtinguiſh *apoplexies* from their cauſe, into *ſanguineous* and *pituitous*; to which may be added *lymphatick*, *polypous*, *ſerous*, *atrabilary*, &c.

Cauſes of Apoplexy. — *Apoplexy* is occaſioned by a ſudden and violent obſtruction of the circulation of the animal ſpirits, through the organs of ſenſe, and a ſuſpenſion of their generation in the ventricles of the brain, proceeding either from an interruption of the paſſage of the blood into the brain, whereby it is deprived of the vital ſpirits neceſſary for the formation of the animal ones; or from an abundance of phlegm, or viſcid pituita, wherewith the brain is oppreſſed, as is obſervable in winter *apoplexies*, or in thoſe of old people; or from a melancholick acid humour that coagulates the blood, or too groſs a lympha which ſtop up the nerves, or a plethora which oppreſſes them; or from excreſcences withinſide the cranium preſſing the veſſels; or from a polypus blocking up the carotydes, &c.

Signs of an Apoplexy. — The fit of an *apoplexy* is uſually preceded by a violent pain of the head, dimneſs, and loſs of ſight or memory. — Sometimes by an univerſal indolence; and ſometimes by a flux of pituitous matter by the noſe and mouth.

Symptoms of Apoplexy. — *Apoplexy* is attended with a ſnoring and difficulty of breathing; ſometimes with a fever, rarely with a foaming at the mouth, frequently with a ſweat, hæmorrhoids, or diarrhæa, and ſo goes off.

Prognoſtick

Prognoſtick of Apoplexy. — *Apoplexy*, in general, is always very dangerous; but much more ſo when it proceeds from a groſs lympha, which obſtructs the paſſage of the animal ſpirits through the nerves; or a coagulated blood; for as that malady cannot be cured but by large evacuations; the groſs lympha cannot be evacuated, till it be rarefied, which rarefaction cannot be done always ſo ſoon, as it would be neceſſary to ſave the life of the patient: neither can the blood be eaſily diſſolved; therefore the patient moſt commonly dies of an *apoplexy* proceeding from thoſe two cauſes; and always of that proceeding from a polypus. — The leſs dangerous is that cauſed by a pituita, or an atrabilis, which can be eaſily rarefied by remedies adminiſtred in time; and theſe are the kinds of *apoplexy* which have theſe intervals, the laſt whereof is almoſt always mortal.

Cure of the apoplexy. — To prevent an *apoplexy*, wine and hard labour are to be avoided; no eating to exceſs; nor no ſleeping after dinner; exerciſe to be kept up; and care and chagrin to be kept under. — To *cure* an *apoplexy*, medicines muſt be uſed that occaſion large evacuations; and nothing of opiate or aſtringents to be meddled withal. During the fit, copious bleeding in the jugulars to be uſed, and the patient laid on his back, applying ſtrong volatiles to the noſe; blowing up ſtrong ſternutatories, and rubbing the temples with cephalick mixtures. A hot iron may alſo be applied near the vertex or occiput; and epiſpaſticks to the neck: to which are added powerful purgatives, clyſters, *&c.* — Cupping, and ſcarifications on the head, are commended by ſome in lieu of venæſection.

Boerhaave preſcribes for the *Apoplexy*, the following *gargariſm*, *maſticatory*, *vomitive*, *purgative*, *fumigation*, and *clyſter*.

Gargariſm. — Take the roots of imperatory, pyrheter, and ſmall galanga, of each an ounce; the leaves of rue, origan, and thyme, of each a handful; flowers of lavender, and matricary, of each an ounce; the bark of winter, ſix drachms: mix all the ingredients to boil in three pints of water, in a veſſel well cover'd, to the diminution of a fourth part; ſtrain the decoction, and to the colature, when cold, add three drachms of ſpirit of ſal armoniack, for a gargariſm, which muſt be uſed cold.

Maſticatory, which excites a ſalivation. — Take maſtick, white wax, ginger, of each an ounce, to make paſtiles, S. A.

Vomitive. — Take an ounce and half of emetick wine, and an ounce of oxymel of ſquills mixed together for a doſe. — Or take ſix grains of *emetick tartar*. — Or take an ounce of the juice of wild radiſh, extracted by expreſſion; two ounces of oxymel of ſquills mixed together for a doſe. — Or take two grains of powder of algaroth.

Purgative. — Take ten grains of diacrydium, ten grains of reſin of jalap, two drachms of rectified ſpirit of wine, mix well all the ingredients together in a mortar, and add to the mixture ſix drachms of laxative ſyrup of roſes compoſed with ſenna, for a doſe.

Fumigation, which irritates the noſtrils. — Take the diſtill'd oils of roſemary of tanſy, of lavender, rue, wormwood, of each four drops, a drachm of the infuſion of caſtoreum, an ounce of the unguent for the nerves, and a drachm of the oleoſum volatile ſalt, mixed together into a balſam, for a fumigation under the noſe of the patient, and to rub the temples withal.

An *acrimonious clyſter.* — Take half a drachm of the pulp of coloquintida, a drachm and half of leaves of tobacco, boil them in ten ounces of water, ſtrain the decoction, and to the colature add two drachms of ſal gemma, for a clyſter.

This remedy is alſo very good for the apoplexy, to help towards the rarefaction of the humours, after the evacuations required have been made. Take twenty drops of volatile ſpirit of ſal ammoniack, fifteen drops of tincture of karabé, and an ounce of water or carduus benedictus, mixed together for a doſe. — This remedy being uſed every month, after the firſt fit, may prevent a ſecond, provided the patient be well purged at leaſt twice a year, with half a drachm of gilla vitrioli, or ſeven grains of emetick tartar.

CARUS is a ſpecies of *lethargick diſeaſe*, conſiſting in a profound ſleep, with a ſudden deprivation of ſenſation and motion, and an acute fever.

Cauſes of the *Carus.* — The *cauſes* of the *carus* are almoſt the ſame with thoſe of the *apoplexy*; the general one being alſo an interruption of the animal ſpirits through the organs of ſenſe, but not ſo abſolute a one as in the *apoplexy*, ſince it proceeds only from an atrabilis, which does not obſtruct entirely the paſſage, and can be eaſily rarefied by the violent agitation, aſſiſted therein by ſome remedies appropriated to the malady.

Symptoms. — The moſt conſiderable ſymptoms of the *carus* is a violent fever, attended with an exceſſive heat, which manifeſts itſelf in a particular manner, on the face; and an almoſt entire privation of the ſenſitive faculty.

Cure. — The ſame remedies uſed in the *apoplexy*, are alſo uſed in the *carus*; but not in ſo large a doſe: and I have even ſeen patients afflicted with that malady, recover their ſenſes by means of the ſmoak of paper burnt under their noſe; or

by rubbing their temples with hungary-water; but the ſureſt remedy is cupping or bleeding.

The COMA is a ſort of *ſleepy diſeaſe*, otherwiſe called *cataphora*; conſiſting in a violent propenſity to ſleep, whether ſleep enſues or not.

Cauſes of the Coma. — The cauſe may be any thing that prevents the courſe of ſpirits; as the cold, humid temperature of the brain: hot putrid vapours aſcending into the head, and ſtopping the canals of the animal ſpirits, narcotick vapours, *&c.* or it may ariſe from the conflict or jarring mixture of bile and pituita.

Cure. — The remedies for a *coma*, are thoſe, which occaſion great evacuations; as violent clyſters, or vomitives; medicines that purge and dry the brain; and thoſe which occaſion revulſions of humours; as veſicatories, cauteries, *&c.* to which may be added volatile ſpirits, ſalts, and moſt cephalicks.

The EPILEPSY is a convulſion, either of the whole body, or ſome of its parts, attended with a deprivation of the ſenſes and underſtanding, and returning from time to time in fits or paroxiſms.

This is called the *falling ſickneſs*.

Cauſe of the Epilepſy. — *Boerhaave* attributes the cauſe of this diſeaſe to too much action of the brain on the motory nerves, and none on the ſenſative ones. Some account for it from the abundance of ſharp humours mixing with the animal ſpirits, and giving them extraordinary and irregular motions and directions; whence ariſes its diſtinction from a ſyncope and apoplexy, which take away all motion as well as ſenſe.

The *Epilepſy* is either *idiopathick*, or *ſympathetick*. It is *idiopathick* when it ariſes merely from a diſorder of the brain or ſpirits: and *ſympathetick* when it is preceded by ſome other diſeaſe.

Symptoms. — The patient ſeized herewith falls inſtantly, and ſuddenly down, or rather throws and precipitates himſelf violently to the ground: when down he grinds his teeth, foams at the mouth, and frequently ſhakes his head; his arms, legs, neck, back, *&c.* either becoming rigid, or variouſly diſtorted. And as all the parts are in a violent contraction, there is frequently an involuntary flux of urine, ſeed, and fæcal matter. After ſome time he returns to himſelf, only retaining a head-ach, heavineſs, wearineſs of the limbs, *&c.*

Cure. — The cure is very difficult; the principal anti epilepticks are, the roots of piony, leaves of lillies of the valley, ſeeds of rue, miſletoe of the oak, or hazel, box-wood, ſpirit of black-cherries, ſpirit of human blood, human ſecundines, human cranium, tooth of ſea-horſe, caſtoreum, peacocks dung, camphire, ſalt, and oil of amber.

To recover a perſon in a fit, tobacco ſmoak, or that of burnt feathers, is recommended. *Barbette*, above all things, directs the flowers and ſpirit of ſal armoniack againſt this diſeaſe. *Crato*, native cinnabar. Sir *John Colbatch* has an expreſs treatiſe on the miſletoe of the oak, to ſhew it is a ſpecifick in this diſeaſe. Elks claws have long had the reputation of the ſame.

MANIA, in *Medicine*, *madneſs*, is a vehement kind of delirium, without a fever.

My ſentiment on the cauſes of this melancholick diſeaſe, is, that it proceeds either from an evil temperature of the brain, or from a bad conformation thereof, and ſometimes from both. That a violent madneſs, attended with rage, fury, *&c.* proceeds from a too great ſiccity of the brain; which thereby being render'd uncapable of moderating the too great impetuoſity of the vital ſpirits uſher'd into it along with the blood, leave thoſe ſpirits to eſcape in the ſame confuſion they are brought in, to the place of their deſtination, the ventricles, where they crowd in too great abundance, and loaded with the impurities they have contracted in the maſs of the blood, and which ſhould have been ſeparated from them by the refrigerating quality of the brain, in their paſſage through it, before their admiſſion into the ventricles; hence enſues a conflict between them and the few animal ſpirits they meet with there, appointed for their further elaboration into animal ſpirits, and directions, but which meeting with ſuch inſuperable obſtacles, are not only fruſtrated in their deſign, but overpower'd by ſo great a quantity of heterogeneous bodies, are themſelves diverted from their natural courſe, and forced to follow the irregular impetuoſity of the prevailing imperfect ſpirits. A *melancholick mania* proceeds from a too great viſcidity of the brain, which obſtruct the paſſage of the vital ſpirits to the ventricles, for the formation of a quantity of animal ſpirits, ſufficient to diſcharge the functions of the ſeveral faculties of the ſoul. And an *alternative mania* proceeds from ſome diſorders in the organs of thoſe faculties, whereby the animal ſpirits are often diverted from their natural determination.

Cure. — The *outrageous mania* is eaſier palliated than any of the two others, becauſe, as it proceeds in part from the too great abundance, and too violent impetuoſity of the ſpirits; that impetuoſity may be moderated by copious evacuations, eſpecially of the blood; and by aliments of little ſubſtance, adminiſter'd with a parſimonious hand.

PALSY, *Paralyſis*, is a diſeaſe wherein the body, or ſome of its parts loſe their motion, and ſometimes their ſenſation or feeling.

Cauſes.

Cauſes.—The cauſes of the *palſy*, are an impeded influx of the nervous ſpirits into the villi of the muſcles; or of the arterious blood into their veſſels; which may happen from ſome fault, either in the brain, the nerves, muſcles, or their veſſels.

Diviſion of the Palſy.—The *palſy* is ſaid to be *perfect* or compleat, when there is a privation of motion, and ſenſation, at the ſame time. *Imperfect*, when one of the two is deſtroyed, the other remaining.

The *palſy* again is either *univerſal*, *lateral*, or *partial*.

Univerſal Palſy, called alſo *paraphlegia*, or *paraphlexia*, is a general immobility of all the muſcles that receive nerves from the cerebrum, or cerebellum, except thoſe of the head. Its *cauſe* is uſually ſuppoſed to reſide in the ventricles of the brain, or in the root of the ſpinal marrow.

The *Paraphlegia* is ſeldom a primary diſeaſe, uſually a ſecondary one, attending, or following an apoplexy, ſcorbutus, carus or arthritis.

Laternal Palſy, called alſo *hemiphlegia*, is the ſame diſeaſe with the *paraphlegia*, only that it affects but one ſide of the body. Its cauſe is the ſame, only reſtrained to one ſide of the brain, or ſpinal marrow.

Partial Palſy, is where ſome particular part or member alone is affected, *e. gr.* where the motion of the arm or leg is deſtroyed.

The *cauſe* of the *palſy*, whether univerſal or partial, is an obſtruction of the paſſage of the animal ſpirits through the nerves; either entire when the part is deprived both of motion and ſenſation; or in part, when it is deprived but of one of thoſe two faculties.

Prognoſtick.—Palſy, whether univerſal or partial, is always incurable in old people; for as the ſource whence the animal ſpirits flow is much exhauſted in them, and conſequently the channels through which they flow to all the parts of the body, much contracted, through the ſcarcity of thoſe ſpirits, which flow then but in a very ſmall quantity through them; thoſe paſſages once obſtructed, thoſe ſpirits flowing neither in a quantity, nor with an impetuoſity capable to conquer them, take another courſe; whereby thoſe paſſages are ſoon entirely contracted, and conſequently rendered uſeleſs.—In young perſons, who abound yet with animal ſpirits, thoſe ſpirits, aſſiſted with medicines, can force their paſſage through the nerves, let the obſtruction be ever ſo great, provided the remedies be well appropriated to the malady.

Cure.—The cure of the *palſy*, according to *Waldſchmit*, does not differ much from that of the venereal diſeaſe. Internally mercurial, ſudorificks, and decoctions of the woods are good: externally unctions, particularly of ſpirituous and penetrating things; and bathing. The *mare*, as they call it in *France*, or the grounds of the grape after the wine has been extracted from it, is alſo an excellent remedy, by putting the patient to ſweat in it.

Here follow the medicines of Dr. *Boerhaave*, for this diſeaſe.—Take maſtich, olibanum, ſuccin, of each half an ounce; mix them together for a powder; which you'll burn on lighted coals, and receive the vapour thereof in a piece of thick flannel, very dry, to rub hard the parts with it. Take three ounces of ſpirit of lavender, two drachms of ſal armoniack, four drachms of tincture of caſtoreum, and ſix ounces of diſtilled water of lavender, which muſt be mixed together to rub the parts therewith. Take plaiſter of cumin, of melilot, galbanum, of each an ounce, and half an ounce of the oil of caſtoreum, for a plaiſter, which muſt be ſpread on leather, and applied on the afflicted part after it has been well rubbed.

Take the infuſed oils of wormwood, anet, camomile, rue, caſtoreum, ſaffron, iris, earth-worms, nardus, of each a drachm; unguent of *Agrippa*, of athanita martiotum, for the nerves, of each ſix drachms; mixed together for a liniment. He preſcribes likewiſe the acrimonious plaiſters of *cuminum*, *galbanum* and *melilot*.

PHRENZY, *phrenitis*, *phreneſis*, is a conſtant and vehement delirium, or diſtraction, accompanied with an acute fever.

It differs from the *mania*, and *melancholy*, in that thoſe are without fevers.

Cauſes.—Phyſicians generally make the *phrenzy* to conſiſt in an inflammation of the meninges of the brain; and diſtinguiſh it from the *paraphrenitis*, which is ſuppoſed to be an inflammation of the diaphragm.

Willis will have them the ſame diſeaſe, and both to conſiſt in an inflammation of the animal ſpirits. He only diſtinguiſhes them as the inflammation ariſes from the cerebrum alone, or from the cerebrum and cerebellum together; and concludes that they both ariſe after a fever, from the boiling blood throwing its aduſt excrements into the brain.

Boerhaave makes the *phrenitis* either true, wherein the cerebrum or meninges, or both are inflamed; or ſymptomatick, where the matter of a fever is tranſlated into the cerebrum.

Prognoſtick.—The true *phrenzy* either kills on the third, fourth, fifth, or ſeventh day; or changes into a mania, lethargy, comus, &c.—Tremors, gnaſhing

gnashing of the teeth, grumous blood distilling from the nose, are prognosticks of death.

Cure.—If the *phrenzy* arises from a suppression of the natural evacuations; those evacuations must be first rectified: but if from any other cause, the too violent motion of the spirits must be appeased first.

Spasm, *spasma*, or *spasmus*, is a great term of equal importance with the Latin *convulsio*, and the English *convulsion*.

Cardan distinguishes two kinds of *spasms*; the first consisting in a constant contraction of the muscles, which renders the members rigid and inflexible. The second, in sudden unnatural motions and palpitations, frequently intermitting and beginning again.

Causes. — *Spasms*, in whatever part of the body they be, arise from the animal spirits meeting with obstructions in their passage through the nerves, which divert them from the natural direction they had received in the cerebrum; whence,

Symptoms. — Proceed the unnatural motions of the parts of the body, a *spasm* is attended with, which are greater or less, more or less frequent, according as the obstructions are greater, and more difficult to conquer.

There are *accidental spasms*, which are of a short continuance, as those arising from flatulencies, or from bites of venomous beasts, or from the puncture of a nerve, from the acrimony of the humours vellicating the stomach, excessive cold, hysterick vapours, *&c.*

There are spasms peculiar to certain members, and distinguished by particular names: that of the mouth is called *spasmus cynicus*; that of the penis *satyriazis*.

The *cynick spasm* is a sort of convulsion, whereby the patient is brought to imitate the gestures, snarlings, howling, *&c.* of a dog.

Dr. *Friend* in the *Philosophical Transactions*, gives us an account of a very extraordinary *spasmus* of this kind, wherewith two families at *Blackthorn* in *Oxfordshire* were seized.

This disease the doctor takes to be natural, and to arise from the common cause of all convulsions, *viz.* from the animal spirits growing unruly in the nerves, and driving the muscles into various contractions, according to the circumstances of the indispositions.

The Nuns of *Loudun* in *France*, so well known throughout the whole world, by the nick-name of *Devils* of *Loudun* (because supposed possessed by the devil) were certainly afflicted with nothing else but a *spasmus* of this kind, though poor *Grandier*, their father director, was unjustly burnt, under the false pretence that he had contributed to their supposed possession; and I really believe that most of the possessions mentioned in Church Histries (those mentioned in the scripture excepted) were nothing else but *spasms* or *epilepsies*.

Prognostick. — A *spasmus* happening after the taking of *Hellebore*, or any other violent purgative, is mortal: *spasms* attended with violent and continual fevers are also very dangerous.

Cure. — The celebrated Dr. *Charleton* prescribes for convulsions the powder of an old raven: all the remedies proper to restore the natural motion of the animal spirits, are good for the convulsions and spasms, as sudorificks, diaphoreticks, *&c.*

Syncope is a deep and sudden swooning, wherein the patient continues without any sensible heat, motion, sense, or respiration; is seized with a cold sweat over the whole body, and all the parts turn pale and cold, as if dead.

Causes. — There are several causes of *syncope*; 1. Too great an exhaustion of spirits, as after long diets, excessive unctions, violent exercises, long bathing, *&c.* — 2. The irregular motion of the spirits, preventing their due influx into the parts, as sometimes happens in fear, wrath, and other violent passions. — 3. In moderate hemorrhages. — 4. An ill constitution of blood, as in cacochymias, or in persons who have taken something that either dissolves or coagulates the blood. — 5. Secret diseases, as abscesses, or polypus's of the heart, worms, *&c.*

Prognostick.—The *syncopes* are very dangerous which arise from hæmorrhages, or from a too great exhaustion of spirits; and those proceeding from abscesses, or polypus's of the heart, are almost always mortal.

Cure.—The volatile spirits and aromaticks, are prescribed for *syncopes*. *Heurnius* recommends treacle water and cinnamon water. And *Etmuller* the volatile salt of vipers, spirit of sal ammoniack, oil of amber, and sometimes bleeding.

Vertigo, is an indisposition of the brain, wherein the patient sees the objects about him as if they turned round, and fancies he turns round himself, though all the while at rest.

Physicians distinguish two kinds, or rather two degrees of *vertigoes*. — The first, called a *simple vertigo*, is when the body and external objects appear to turn round, without any great dimness of sight.

The other called *scotania*, or *vertigo tenebrosa*, is when the eyes are also darkened, and as it were covered with a mist.

Some make a third stage, *viz. vertigo caduca*, wherein the patient actually falls down. But this seems scarce to differ from an epilepsy.

Sometimes

Sometimes the *vertigo* is ſeated in the fore part of the head, and ſometimes in the hind part; the latter is much more dangerous.

Cauſes of the vertigo.—*Bellini* accounts for the *vertigo* very well, from a preternatural motion in the retina.

The *external cauſes of vertigoes* are a continued turning round of the body, drunkenneſs, too long faſting, immoderate exerciſe, ſurprize, voracity, much uſe of pulſe, onions, leeks, radiſhes, cabbage, muſtard, *&c.* and in general whatever may preſs, diſtend, or contract the arteries.

Cure of the vertigoes.—The firſt ſtep in the cure is bleeding in the jugular or cupping; then they proceed to an emetick; then a veſiccatory on the neck, or a perpetual bliſter, or iſſues; with ſternutatories and other medicines, that obtained in the apoplexy.

Diſeaſes of the THROAT. The QUINSEY, called alſo *angina*, is an inflammation of the throat, and particularly of the muſcles of the larynx or pharynx, which exactly cloſing the chinks thereof, prevent the air from paſſing in and out of the trachea, and the food from being ſwallowed and conveyed into the ſtomach.

Cauſes of the quinſey.—The *quinſey* is cauſed by a defluxion of blood, either pure or bilious, from the branches of the carotide arteries; and there cauſing a phlegmon, either a ſimple or an eryſipelatous one.

Symptoms of the quinſey.—The general ſymptoms of the *quinſey* are, that it is always attended with a difficulty of reſpiration, and of deglution. The *true quinſey* is always attended with a fever. And the *ſpurious* is free from it.

Prognoſtick of the quinſey.—That *quinſey* is of all others the moſt dangerous when the tumour is neither perceivable on the inſide nor the outſide. That appearing on the outſide is the moſt curable.

Cure of the quinſey. In the *external quinſey*, before any ſuppuration appears, recourſe is had to repeated veneſection in the jugulars.—Veſicatories and cupping are alſo uſed with emollient gargles, *&c.*

The following is an excellent gargle for the *quinſey*.—Take two ounces of the beſt honey; the buds of black-berry buſhes, and dried red roſes, of each a handful; put them to boil together in three pints of river-water, for the ſpace of half a quarter of an hour, ſkimming well the decoction, and ſtraining it afterwards with expreſſion; the colature is the gargle, wherewith the patient muſt gargle his throat as often as poſſible.

In *violent quinſeys* recourſe ſhould be had to laryngotomy, or bronchotomy, which though rarely practiſed, may yet be uſed with ſafety.

Diſeaſes of the THORAX *or* BREAST. The principal maladies of the *breaſt* are the *empyema*, *aſthma*, *phthiſick*, *peripneumony*, *pleuriſy*, &c.

The EPYEMA is a collection of pus, or purulent matter, in the cavity of the breaſt, diſcharged thither upon the buſting of ſome abſceſs or ulcer, in the lungs or membranes that incloſe the breaſt.

Signs of the empyema.—The *empyema* is diſtinguiſhed by a difficulty of breathing, a dry cough, a heavineſs about the diaphragm, a noiſe, and fluctuating of the matter upon moving; ſlow fever, ruddy cheeks, hollow eyes, the tips of the fingers hot, and a ſwelling of the abdomen.

Cure of the empyema.—The difficulty of the cure of this diſeaſe proceeds from the difficulty of abſorbing, or evacuating ſuch extravaſated matter: if nature ſhews any endeavour to throw it off by vomiting or urine, or the like, ſhe muſt be ſeconded, and aſſiſted therein. Thus, if the urine be purulent, adminiſter dieureticks. If the ſtools, laxatives. If the ſpitting, expectorants or even emeticks; though I would not adviſe to attempt this laſt remedy, but with the utmoſt caution, leſt the patient ſhould be ſuffocated in the operation.

There is alſo a kind of *ſpurious* or *baſtard empyema*, proceeding from a pituitous or ſerous humour, brought by ſome duct or paſſage into the thorax; where corrupting, it degenerates into a matter like pus. An *empyema*, in courſe of time, breeds a *phthiſis*.

The *Aſthma* is a difficulty of breathing, ariſing from a diſorder of the lungs; and uſually attended with violent motions of the diaphragm, abdominal, and intercoſtal muſcles, to the very ſcapula, and the pinnæ of the noſtrils; as alſo a rattling in the throat.

If reſpiration be only thick and quick, without the other ſymptoms, it is called a *Dypſnæa*. If it be ſo intenſe as to occaſion a violent motion of the muſcles of the thorax, ſo that the patient cannot be tolerably eaſy, except in an erect poſture, it is called *orthopnæa*.

The *aſthma* is uſually divided into *moiſt* and *dry*, or *manifeſt* and *occult*, or *pneumonick* and *convulſive*. The firſt attended with an expectoration of purulent matter: the latter without.

Cauſes of the true, or *pneumonick aſthma.*—The *true* or *pneumonick aſthma*, is occaſioned by an abundance of ſeroſities, or of groſs, viſcous or purulent humours, collected in the cavity of the lungs, which ſtop up, or ſtreighten the paſſages of the air, and compreſs the bronchia. It may alſo be owing

owing to empyema's, phthiſis's, polypus's, crudities in the ſtomach, cachexies, *&c.*

Cauſes of the convulſive Aſthma.—The *convulſive aſthma* is ſuppoſed to be occaſioned by an irregular motion of the animal ſpirits; and happens when the ſpirits do not flow faſt enough, or in ſufficient quantity into the muſcles of the breaſt, either by the reaſon of an obſtruction, or ſome other obſtacle: the neceſſary conſequence whereof is a violent and painful reſpiration. The *aſthma* again is either continual or periodical, and intermitting; which laſt returns where a ſober regimen is not obſerv'd.

Symptoms of the aſthma.—The greateſt ſymptoms of the *aſthma*, are an extreme difficulty of reſpiration, eſpecially when the patient is in bed, and in a prone poſture; the contents of the lower belly in that caſe, bearing againſt the diaphragm, ſo as to leſſen the capacity of the breaſt, and to leave the lungs leſs room to move.——It is alſo always attended with a violent dry cough.

Cure of the true, or *pneumonick aſthma.*—What I call cure, in this place, are only the means uſed to eaſe the patient in the moſt violent paroxiſms of the diſeaſe, and render them leſs frequent, which is done by bleeding; after which emeticks may be uſed; and if the paroxiſm returns, epiſpaſticks, with clyſters inſtead of purges. Infuſions of *fim. equin.* or the juice thereof, being deterſive and attenuating, are reputed excellent. Linctus's alſo give ſome relief; millepedes, ſpirit of gum ammoniack, with ſal ammoniack, coffee, tincture of ſulphur, *&c.* are commended in *aſthmatick* caſes.

The *cure of the convulſive kind*, is attempted by anti-epileptick, anti-hyſtericks, anti-ſpaſmodicks, opiates, *&c.*

Phthiſick in its general ſenſe, denotes any kind of conſumption of the body, in what part ſoever it be ſeated, or from what cauſe ſoever it ariſe. Thus we have a nervous *phthiſis*, and renal *phthiſis*, dorſal *phthiſis*, pulmonary *phthiſis*, &c.

But *phthiſis*, in its proper ſenſe, is reſtrained to a pulmonary conſumption, or a conſumption ariſing from an ulcer, or other diſorder of the lungs, accompanied with a ſlow hectick fever, which waſtes, extenuates, and conſumes the muſcular fleſh.

Cauſes of the phthiſick.—*Sydenham* obſerves, that the *hectical phthiſis* has its origin in the winter's cold; from a ſharp humour trickling down upon the lungs, where like a catarrhea, it irritates them ſo as to raiſe a cough. Among the cauſes of this diſeaſe may be reckoned intemperance, as it brings on a plethora or cacochymia, peripneumonies, aſthma's, pleuriſies, *&c.*—*Morton* adds that the *phthiſis* frequently ariſes from an ill conformation of the breaſt; which is either natural, as when the breaſt is too narrow, the neck too long, *&c.* or accidental, where there happens a curvity or diſtortion of the breaſt.

Symptoms of a hectical phthiſis.—This diſeaſe is attended with a ſpitting, firſt of a viſcid pituita, then a heavy fetid pus, then of pure blood, and ſometimes of the very ſubſtance of the lungs rotted by ulceration; with night-ſweats, falling of the hair, and colliquative flux, which is ſoon follow'd by death. *Sydenham* ſays, that the *phthiſis* kills two thirds of thoſe who die of chronick diſeaſes. Among the ſymptoms *Morton* reckons a nauſea, or reaching, with a heat in the palms of the hands, and redneſs in the cheeks, all after eating.

In the laſt ſtage of the *phthiſis*, the noſe appears ſharp, the eyes, hollow, the temples fallen, the ears cold and contracted, the ſkin about the forehead hard and dry, and the complexion greeniſh, or livid, *&c.* which is called *facies hypocratica.*

Prognoſtick.—A confirmed *hectical phthiſis*, is almoſt always incurable, and conſequently mortal, becauſe then almoſt the whole ſubſtance of the lungs is ſuppoſed ulcerated, the which it is impoſſible to reſtore to its former laudable conſiſtence.

Cure of an hectical phthiſis.—Though the cure of this diſeaſe be extremely difficult, *Sydenham* adviſes, the defluxion on the lungs, in the firſt ſtage to be abated by blood-letting, *&c.* and pectoral to be uſed, accommodated to the various ſtates of the diſeaſe, *viz.* incraſſants, attenuants, to aſſwage the hectick, *&c.* with emulſions, aſſes-milk, *&c.* and balſamicks to cure the ulcer.

But he is of opinion, that the chief aſſiſtance in this is from riding on horſeback, where the patient need not confine himſelf to any laws of diet, *&c.* this alone, he adds, is almoſt as ſure a cure for a *phthiſis*, as the cortex for an intermitting fever.

Dr. *Baynard* recommends butter-milk, as an admirable ſuccedaneum to aſſes-milk. *Sylvius* ſays he knows of no medicine, either internal or external, ſo good againſt freſh ulcers of the lungs, as balſam of ſulphur, eſpecially when prepared with oil of anniſeed.

Etmuller obſerves, that vomitories are good in a beginning *phthiſis*, purgations by all means to be avoided; and commends the uſe of medicines made of tobacco.

Bonetus holds the *phthiſis* to be contagious; and that there are frequent inſtances of it being communicated by cloaths, linnen, beds, *&c.* I would not affirm, that it can be communicated by theſe things, but I have ſeen it communicated by laying in the ſame bed with a *phthiſical* perſon. I would not even adviſe any body to eat or drink after a perſon affected with a conſummate *phthiſis.*

Pitcairn

Pitcairn recommends *mercurius dulcis*, in the beginning of a *phthiſis*; and *Barbette* and *Colbatch* aſſert, that contrary to the opinion of moſt authors, they have frequently uſed acids with ſucceſs in the *phthiſis*.

Boerhaave preſcribes the following remedies for an *hectick phthiſis*.

A *conditum*.—Take three ounces of conſerve of red roſes; two drachms of bol armoniack reduced into an impalpable powder; and as much ſyrup of myrtle, as is neceſſary to make a conditum; of which the patient ſhall take half a drachm every two hours.

A *conſerve*.—Take three ounces of the leaves of plaintain, while yet very tender, an ounce and a half of flowers of wild poppies; and an ounce of the ſeed of plaintain, newly gather'd; mix all theſe ingredients with a ſufficient quantity of ſugar, to make a conſerve, of which the patient ſhall take half a drachm every two hours.

A *decoction*.—Boil two handfuls of ſorrel in a pint of whey, ſtrain the decoction, and give every hour a glaſs thereof to the patient.

To promote a cure of this diſeaſe abſtain from all ſorts of ragouts, fricaſſees, and all kinds of diſhes, where too much ſalt or ſpices are introduced; of all ſorts of pulſes, or other windy aliments; of all ſpirituous liquors, unleſs it be thoſe, which are truly cordial, as the ratafia, ros-ſolis, *&c.* and even thoſe muſt be uſed with a great deal of moderation; abſtaining above all things from beer, or any other ſuch liquor; and from any meat which is not of a light digeſtion, or that can promote a looſeneſs; preferring roaſted to boiled meat, drinking always the oldeſt wine, and the moſt cordial; eating ſweetmeats often, and other dry aliments.

For common drink a ptizan, made of jujubes, and dates, of each four ounces; a handful of the ſmalleſt maiden-hair; two ounces of liquorice ſcraped and ſtringed; and two golden pippins, cut in quarters; all theſe ingredients to be boiled together, in three quarts of river-water, to the conſumption of a ſixth part; the jujubes and dates having been open'd before they are put to boil. Of this ptizan the patient may drink as much as he pleaſes.

PLEURISY is a violent pain in the ſide, attended with an acute fever, a cough, and a difficulty of breathing.

Cauſes of the pleuriſy.—The *pleuriſy* ariſes from an inflammation of ſome part of the pleura, to which is frequently joined that of the exterior and ſuperficial part of the lungs. It uſually ariſes upon cooling too haſtily, after violent heat; as by drinking cold water, laying open to the air, *&c.*

This inflammation ſeizes any part of the teguments of the thorax, *viz.* either the pleura or mediaſtinum; and therefore the pricking pain may be felt in any part of the thorax: but the place it moſt ordinarily infeſts is the ſide; ſometimes the left, ſometimes the right, ſometimes higher, ſometimes lower.

This makes what we call the *true* or *internal pleuriſy*; in oppoſition to the *ſpurious* or *external pleuriſy*, which is a pain in the ſide without any fever, and frequently without any cough; and is ſuppoſed to ariſe from a ſharp ſeroſity, lodged in the pleura, or higher among the internal muſcles.

Symptoms of a pleuriſy.—The *ſymptoms* of a *true* pleuriſy, is a ſharp and fixed pain commonly in the left ſide, attended with a violent fever, and a great difficulty of breathing; and alſo with a ſhort dry cough. A *falſe* pleuriſy is only attended, as already obſerved, with the ſame pain, difficulty of breathing, and cough, but without fever.

Prognoſtick.—Both *pleuriſies*, either *true* or *ſpurious*, are very dangerous, and require a ſpeedy relief; and when after the neceſſary remedies have been adminiſtered, the ſymptoms increaſe inſtead of diminiſhing, or even remain the ſame, the diſeaſe is mortal.

Cure.—The great remedy in the true pleuriſy is copious and repeating bleeding. In adults, *Sydenham* obſerves, is ſeldom cured with leſs than the loſs of forty ounces of blood.

Boerhaave preſcribes the following remedies to be applied inwardly for the *pleuriſy*.

Fomentation.—Take mallows, marſh-mallows, and parietary, of each two handfuls; red poppies and henbane, of each a handful; flowers of elder, of camomile, and of melilot, of each three ounces; boil all theſe ingredients in new milk, for a fomentation.

Liniment to anoint the ſides.—Take four drachms of ſugar of ſaturn; ſix drachms of vinegar; and an ounce of oil of roſes extracted by infuſion; mixed together for a liniment to anoint the ſides.

Internal remedies.—A *decoction*.—Take leaves of tuſſilage, and of marſh-mallows, of each two handfuls; flowers of red poppies, and of althæa, of each a handful and an half; parſley roots, ſarſaparilla, of each three ounces; four drachms of linſeed bruiſed; of lettuce, and of carduus dominæ, of each an ounce: boil all the ingredients together in a ſufficient quantity of water, that there may be three pints left, whereof the patient ſhall drink two ounces every hour.

An *emulſion*.—Take the four great cold ſeeds, and the four ſmall ones, of each three drachms; two ounces of ſeed of white poppies; mix them all together with barley-water, for an emulſion, with

fourteen ounces thereof ſhall be mixed a drachm and half of pure nitre; and an ounce of ſyrup of maiden-hair: of which emulſion the patient may drink a glaſs every quarter of an hour.

PERIPNEUMONY is an inflammation of ſome part of the thorax, properly of the lungs, attended with an acute fever, and a difficulty of breathing.

The *peripneumony* is diſtinguiſhed into *true*, and *ſpurious*.

The *true peripneumony* is a real inflammation of the ſubſtance of the lungs, attended with a ſymptomatical fever and a cough; by the former of which it is diſtinguiſhed from an aſthma, and by the latter from a pleuriſy.

Cauſes of the true peripneumony.—Its uſual cauſes are want of exerciſe, hard ſtudy, ſuppreſſion of natural evacuation, or moiſt air, and the like.

Symptoms.—When the *peripneumony* ariſes from a phlegmon, the patient ſpits pure blood; when it is eryſipelatous, the ſputum is yellow, and not much tinged with red. In this laſt the breaſt is not ſo much contracted, but the fever more violent.

Prognoſtick.—The *peripneumony* is more dangerous, though leſs painful than a pleuriſy, particularly in young people which are ſoon carried off: its uſual way of going off is by expectoration of well concocted, reddiſh, yellow, or white matter. The flowing of the menſes, or any hæmorrhage, a diarrhæa, abſceſſes about the ears or other parts, are alſo good prognoſticks.

Cure.—The medicines preſcribed for the cure of the *peripneumony*, are moſtly the ſame that obtain in aſthmatick and pleuritick caſes.

Dr. *Boerhaave* preſcribes the following remedies.

Decoctions.—Take forty ounces of a decoction of barley, two drachms of nitre, and four ounces of oximel; mix them together, of which the patient ſhall drink two ounces, warm, every quarter of an hour. Or take the leaves of parietary, agrimony, dendelion, of each a handful; the ſeeds bruiſed of white poppies, and of fennel, of each an ounce; liquorice, an ounce and a half; to make fifty ounces of decoction; which muſt be drank in the ſame manner as that above preſcribed.

Aliments.—Pulſes, farinous matters, peaſe, and ſummer fruits, ripe.

Spurious, or *baſtard* PERIPNEUMONY is a diſeaſe of the lungs, ariſing from a heavy pituitous matter generated throughout the whole maſs of the blood, and diſcharged upon the lungs.

Signs.—The *ſpurious peripneumony* is known by the viſcidity, paleneſs, and ſlowneſs of the blood, ropineſs of the ſaliva, paleneſs, and want of ſcent of the urine, ſwellings and obſtructions in the minuter veſſels, ſhort breath, oppreſſion in the throrax, *&c.*—Worn out, phlegmatick, cold, phthiſical, catarrhous conſtitutions, are moſt liable to it.

Symptoms.—It begins with a feebleneſs, indolence, wearineſs, difficulty of breathing, oppreſſion of the breaſt, feveriſhneſs; and goes on, without any great appearance of danger, to death itſelf; without any prognoſtick thereof in the urine, pulſe, *&c.*

Cure.—This diſeaſe is cured by blood-letting, clyſters, thin diet, diluters, aſtergents, and aperients.

Dr. *Boerhaave* preſcribes the following remedies, for the *ſpurious peripneumony*.

Clyſter.—Take three ounces of honey; a drachm of nitre; a yolk of an egg, and eight ounces of a decoction of barley for a *clyſter*.

A *decoction.*—Take two ounces of the roots of fennel, four ounces of gramen; of leaves of parietary, and of agrimony, of each a handful and an half; an ounce of the ſeeds of white poppies, bruiſed; and an ounce and a half of liquorice: boil all theſe ingredients together, in ſuch a quantity of water, as there may be two pints of the decoction left; two ounces hereof the patient muſt drink every two hours.

CONSUMPTION is a diſeaſe ariſing from a defect of nouriſhment; or a preternatural decay of the body, by a gradual waſte of muſcular fleſh.

A *conſumption* may be either *accidental*, *natural*, or *hereditary*.

Cauſes of an *accidental conſumption.*—*Accidental conſumptions* may ariſe, 1. From ulcers, chalky ſtones, or polypus's in the lungs, cauſed by ſomething that obſtructs the circulation in the pulmonary veſſels, or renders the blood viſcid, as a ſuppreſſion of any natural evacuation.—2. From intemperance, occaſioning either a cacochymia, or plethora.—3. From peripneumonies, pleuriſies, aſthma's, coughs, catarrhs, diarrhæa's, venereal diſorders, and exceſs of venery.—4. From grief, hard ſtudy, *&c.*

Cauſes of *natural conſumptions.*—Natural conſumptions may ariſe from the thorax, or an evil conformation of the parts.

Cauſes of an *hereditary conſumption.*—An hereditary conſumption may be communicated from the parents without any other viſible cauſe.

Symptoms.—A *conſumption* uſually begins with flying pains and ſtitches; pain at the pit of the ſtomach, or in the diaphragm; frequent ſpitting, loſs of appetite, a quick pulſe, a ſweetneſs or ſaltneſs in the ſaliva, heats and flushings in the face and palms of the hands after meals, and hectick fever towards the evening, heavineſs, faintneſs, night-ſweats; and where the lungs are firſt diſordered,

ordered, a cough, catarrh, or aſthma uſually precede it.

When theſe ſymptoms are violent it is confirmed; and then comes on an expectoration of purulent or bloody matter, and the vomica pulmonum; at length the feet ſwell, the expectoration ſtops; a diarrhæa comes on; then the facies hippocratica, and death.

Cure of an *univerſal*, or *maſcular conſumption*.—The cure of this dangerous diſeaſe depends principally upon removal into a proper air; alſo upon a regular nouriſhing diet: and the appetite is to be excited by proper bitters, and other ſtomachicks.

In a *pulmonary conſumption*, or *phthiſis*, balſamick medicines, and vulnerary medicines, a great quantity of oleaginous medicines is uſed in theſe caſes, but I am of Dr. *Wainwright*'s opinion, that the particles of oily medicines are too groſs and viſcid to enter the ſmall orifices of the lacteals; and think that their operation or effect being confined to the firſt paſſages, they are not only of no ſervice in the cure, but are apt to pall the appetite, occaſion obſtructions in the mouth of the lacteals, and diarrhæas.

A COUGH is a diſeaſe affecting the lungs, occaſioned by a ſharp ſerous humour, vellicating the fibrous coat thereof, and urging it to a diſcharge by ſpitting, *&c.*

When the humour is ſo ſubtile that the lungs cannot lay hold of it to throw it off, or when the humour is ſo thick that it will not give way, it is ſaid to be a *dry cough*.

Prognoſtick.—*Dry coughs* are the moſt dangerous.—*Hippocrates* ſays, that *cough* ceaſes if the teſticles ſwell.

Cure.—A pectoral ſyrup, and decoctions, are medicines for a cough of any kind whatever; and a few drops of laudanum may be adminiſtered with ſafety, to appeaſe the violence of the paroxiſms, and prevent ſome dangerous conſequences it may be attended with; as the breaking of ſome blood-veſſels, and the burſting of abſceſſes, if there were any in the capacity of the thorax.

The HICKUP is a convulſive motion of the diaphragm, whereby that muſcle retiring impetuouſly downwards, impels the parts beneath it.

Cauſes of the hickup.—The *hickup* is occaſioned by ſharp humours, a too great plenitude of the ſtomach, a bit of any thing ſtopped at its upper orifice; or, in general by any thing capable of irritating the nerves of the diaphragm.

Note, That the *hickup* is a very dangerous ſymptom, in a chronical diſeaſe.

Cure of the *hickup*.—The remedy for the *hickup*, according to *Hippocrates*, is to fetch the breath very long; or even to ſtop the breath for ſome time. A ſneezing happening upon a *hickup* generally cures it; the diaphragm ſhook by the violent expiration, being apt to throw off what before irritated it.

As the chief ſeat of the blood is in the *thorax*, where it receives its laſt degree of perfection in the ventricles of the heart; and the blood is, as it were, the focus of ſeveral very dangerous maladies, the human body is afflicted with; or, to ſpeak more properly and clearly, as from the diſorders, intemperies, or corruption of the maſs of blood, ariſe the greateſt part of the maladies we are ſubject to, I'll treat in this place of thoſe different maladies, beginning by *fevers* of all kinds.

A FEVER, *febris*, is a diſeaſe or rather claſs of diſeaſes, proceeding from an exceſſive effervescency of the blood, occaſioned by its being obſtructed in its circulation.

The truth whereof appears from the different *periodical* changes, or *paroxiſms*, a *fever* is attended with.

1. The firſt indication we have of a fever is from the pulſe being quicker than uſual; which quickneſs does not proceed, as ſome imagine, from the blood being then accelerated, but rather from its being obſtructed in its circulation; which obſtruction hindering the uſual quantity of blood from falling into the ventricles of the heart, and conſequently their dilating themſelves to their natural extent to receive it, and contracting themſelves as uſual to expel it; render that dilatation and contraction more frequent; and therefore the pulſation of the arteries quicker.

The next thing ſenſible in a fever is a certain chillneſs, becauſe as the natural heat is communicated to the extremities of the body, by means of the circulation, that circulation once obſtructed, that heat diminiſhes every where, as being then deprived of the ſupplies it received continually from its natural ſource. Till the vital ſpirits crowding to that part where the obſtruction happens, there enſues a conflict between them and the morbifick matter, whence an exceſſive effervescency, in the maſs of the blood, which cauſes that violent heat, which ſucceeds to the chilneſs, and which laſts, till the blood has conquer'd the obſtacle, forced its way thro', and re-aſſum'd its former courſe; then the paroxiſm diminiſhes.

Cauſes of fevers.—The cauſes of fevers are innumerable; and the diſeaſe even often ariſes in the ſoundeſt bodies, where there was no previous morbifick apparatus; as cacochymia, plethora, *&c.* but merely from a change of air, food, or other alteration in the non-naturals. A fever, *Boerhaave* obſerves,

obſerves, is an inſeparable companion of an inflammation.

Symptoms of fevers.—The ſymptoms are many; every fever ariſing from any internal cauſe, is attended with a quick pulſe, and unuſual heat, at different times, and in different degrees. Where theſe are intenſe, the fever is acute; where remiſs, ſlow.

The diſeaſe begins almoſt always with a ſenſe of chilneſs; and in its progreſs is chiefly diſtinguiſhed by the velocity of the pulſe: ſo that a too quick contraction of the heart, as already obſerved, furniſhes the proper idea of a fever, and the health of the patient is the ſcope nature chiefly aims at in the diſeaſe. Other attendant ſymptoms are uſually a laborious and diſturbed reſpiration, an uniform, high-colour'd urine; a parchedneſs and dryneſs of the tongue, mouth, *&c.* a clammineſs of the ſaliva; thirſt; wakefulneſs, and nauſea againſt every thing but thin diluting liquors.

Cure of the fevers.—The general indication in the cure of fevers is to raiſe the obſtructions, which hinder the eaſy circulation of the blood, by evacuating the morbifick matter which cauſes thoſe obſtructions; or at leaſt fixing it in ſuch a manner, that circulating no longer with the blood, it may be eaſier evacuated.

The cure of fevers, *Boerhaave* ſummarily comprehends in correcting the ſharp, irritating ferbile matter, diſſolving the lentor, and mitigating the ſymptoms. If nature ſeems to carry the fever too high, it muſt be moderated by abſtinence, thin diet, drinking of water, bleeding, and cooling clyſters. If ſhe brings it on too ſlowly, it muſt be excited by cardiacks, aromaticks, volatiles, *&c.*—The cauſe removed, the ſymptoms ceaſe of courſe; and if they can be bore without much danger of life, it were beſt not to enter into any particular cure thereof: if they be unſeaſonable, or too ſevere, they are each to be abated with the proper remedies.

Sydenham recommends an emetick in the beginning of a fever; or if it have been then omitted in any other ſtage thereof; eſpecially where there is a propenſity to vomiting: for want of this, a diarrhæa frequently ſucceeds, which is exceedingly dangerous. After this he uſes a paregorick; and the following days, if there be no indication to repeat the venæſection, nor any diarrhæa, he preſcribes, every other day an enema, till the twelfth day, when matters coming to a criſis, he has recourſe to hotter medicines, in order to promote and accelerate it. He adds, that if the diſeaſe proceed well, and the fermentation be laudable, there is no occaſion for any phyſick at all. About the fifteenth day, if the urine be found to ſeparate, and give a ſediment, and the ſymptoms be abated, a cathartick is uſually ordered, leſt the ſediment returning into the blood again, occaſion a relapſe.—Nothing cools the patient, and abates the fever, ſo much as a cathartick after venæſection.

The more acute the fever, the thinner, according to *Etmuller*, muſt be the diet. It is no matter if the patient ſhould faſt for ſeveral days running; for never did feveriſh perſons die of hunger: eating always exaſperates the diſeaſe. Vomitories, he allows the principal place in the cure of all fevers; but as a patron of the hot regimen, aſſigns ſudorificks the ſecond. Spirit of ſal ammoniack, or its ſal volatile, he obſerves, is an univerſal febrifuge, and rarely fails. All ſugar things are hurtful.

Prognoſtick—So long as the urine remains crude, that it does not give a ſediment, the patient's caſe is dubious: but when once the coction commences, and the urine ſeparates, the great danger is over. Among the ſigns of death, ſome authors are of opinion, that there is none more certain than a frequent blowing of the neſe without any diſcharge of matter. A ſtrong, equal pulſe, with deliria, tremors, twitches of the tendons, and other ſymptoms, fatal in the diſeaſes of the nervous kind, always preſage well in fevers. On the contrary, a quick, weak, faltering pulſe, however favourable the other ſymptoms may ſeem, infallibly proclaim death at the door, ſays Dr. *Morton*.

Note, That it appears by obſervation, that a frequent letting of blood, renders perſons more inclinable to fevers.

The moſt general, and genuine diviſion of fevers, is into *eſſential* and *ſymptomatick*.

Eſſential fever is that, whoſe primary cauſe is in the blood itſelf; and which does not ariſe, as an effect, or ſymptom, from any other diſeaſe in the ſolids, or other parts. This is what we abſolutely and properly call a *fever*.

Symptomatick fever is that, which ariſes, as an accident or ſymptom of ſome other antecedent diſorder, as an inflammation, phlegmon, eryſipela's, impoſthume, ſmall-pox, pleuriſy, *&c.* Whence it is particularly denominated *inflammatory*, *eryſipelatous*, *purulent*, *variolous* or *pleuritick fever*.

Eſſential fevers are generally diſtinguiſhed into *continued* and *intermitting*:——Others chuſe to divide them into *diary*, *intermitting*, *continent*, and *continued*.

Continual fever is that, which gives the patient no reſpite or intermiſſion. This is ſub-divided into *putrid* and *not putrid*.

Continual fever not putrid, is that, wherein the parts of the blood are not ſo diſſolved and broke, as as to give occaſion for the principal parts thereof to be ſecreted, or that wherein there is not any diſ-

charge

charge of putrid, purulent matter into the blood. Of this there are two kinds, the *diary* and *ſynochus*; to which ſome add the *hectick*.

Diary fever is that, which does not ordinarily hold beyond twenty four hours. It is frequently got by too much exerciſe, or other external accidents; and cured by reſt alone, and keeping a-bed: —If it remains for ſeveral days, it is either called a continual *ephemera*, or a ſimple *ſynochus*.

Hectick fever is a ſlow durable *fever*, which extenuates and emaciates the body by inſenſible degrees.

It has three ſtages:—the firſt, while it conſumes the juices of the body:—the ſecond, when it exhauſts the fleſhy ſubſtance of its humidity: and the third, when it lays hold of, and deſtroys the ſolids themſelves; in which laſt ſtage it is reputed incurable.

Continual putrid fever is that, wherein the texture of the blood is rendered ſo lax, or even diſſolved, that its parts or principles ſeparating, ſome of the principal are ſecreted, and loſt.

Putrid fevers are frequently conſidered as *ſecundary* ones, ariſing from the diſcharge of putrid, purulent matter from ſome morbid part; as an ulcer in the lungs, &c. They are divided into *ſimple* and *compound*, or *remitting*.

Simple continual putrid fever, or a *continent fever*, properly ſo called, by the *Greeks* Συνοχὼ, is that which continues uniformly from firſt to laſt, without any fits, or periods of exaſperation and remiſſion of heat, and the other ſymptoms.

Willis divides the *putrid fever* into four ſtadia or ſtages. The beginning, which is attended with a chilneſs, ſhivering, wearineſs, thirſt, wakefulneſs, pain in the head and loins, nauſea and vomiting. The increaſe, wherein the former ſymptoms are heightened, with the addition of deliria, convulſive motions, foulneſs of the mouth, high turbid urine without any laudable ſediment or hypoſtaſis. The ſtate, which contains the criſis, which in this diſeaſe is much what the paroxiſm is in *intermittents*: for, as that returns at certain hours, ſo do the critical motions in continued fevers happen on the fourth, fifth, ſixth, and ſeventh day. The laſt ſtage is the declenſion, which ends either in recovery or death.

Theſe *fevers* are ſubdivided into *burning* and *ſlow*.

Ardent, or *burning fever*, is a very acute *fever*, attended with a vehement heat, intolerable thirſt, a dry cough, delirium, and other violent ſymptoms.

Prognoſtick. It frequently kills on the third or fourth day, rarely exceeds the ſeventh. It often goes off in an hæmorrhage, on the third or fourth day; which, if it proves too ſparing, is mortal. Sometimes it goes off by ſtools, vomiting, &c. and ſometimes ends in a peripneumony.

To the claſs of *burning fevers* are reducible, the *liperia*, *aſſodes*, *helodes*, &c.

The *liperia* is a burning fever, wherein the heat is very intenſe within ſide, and at the ſame time the external parts are cold.

The *aſſodes* is a burning fever, attended with great inquietudes, nauſeas, vomiting, &c.

The *helodes* is a fever, wherein the patient ſweats continually.

The *ſyncopal fever* is that attended with frequent ſwoonings.

The *epialo* is that, wherein both heat and cold are felt in the ſame part at the ſame time.

Slow fevers are gentle, but durable ones, which conſume the patient by degrees. They uſually ariſe from diſorders in the lympha or pituita, whence *Sylvius* calls them *lymphatick fevers*.

The principal of theſe are the catarrhal, attended with a catarrh, cough, hoarſeneſs, &c. And the *ſcorbutick fevers*, into which acute fevers, and ſometimes *intermittents* degenerate. To this claſs are alſo reducible,

Colliquative fevers, wherein the whole body is conſumed and emaciated in no long time; the ſolid parts, with the fat, &c, melted down, and carried by a diarrhæa, ſweat, urine, &c.

Remitting fever, called alſo a *continual fever*, and a *compound continual fever*, is that which continues ſome time without any gradual increaſe of heat; yet is liable to alternate fits of remiſſion and aggravation; either ſtated and periodical, or irregular.

Of this there are divers kinds, denominated from the periods of returning; as the *remitting*, *continual quotidian*, *continual tertian*, *continual quartan*, &c. which are only a continued *fever*, whoſe acceſſes or ſeverer fits return every day, or every other day, or every third day, or every fourth day.

Some enumerate divers other more complicated continual *fevers*, as the *double* or *triple quotidian*, which has two or three paroxiſms every day: *double* or *triple tertian*, or *quartan*, which has two or three every third or fourth day: the *ſemi-tertian*, which conſiſts of a continual and two intermitting *fevers* of different kinds, *viz.* a *quotidian* and *tertian*. The patient, beſides a continual fever, having an extraordinary fit every day, and every other day two.

Others divide the *remitting*, or *compound continual fever*, into *ſimple* and *ſpurious*.

The *ſimple remittent* returns regularly, and is only diſtinguiſhed from an *intermittent*, in that the feveriſh heat in the intervals of this latter is never quite extinguiſhed; and that the paroxiſms do not begin with

with ſo much chilneſs and horror, and goes off in profuſe ſweats.

The *ſpurious remittent* is attended with grievous ſymptoms in the nervous kind, reſembling thoſe of the rheumatiſm, cholick, pleuriſy, and other inflammatory and ſpaſmodick diſeaſes; beſides immoderate excretions, vomitings, diarrhæa's, *&c.* whence its returns are uncertain and variable.

The *ſimple* rarely, if ever, kills: the *ſpurious* frequently. Sometimes it degenerates into a malignant Συνοχὼ.

Cure of theſe fevers. The firſt is cured with the *quinquina*, or Jeſuits bark, almoſt as infallibly, as an intermittent; the febrile ferment being much the ſame in both; and the ſame remedy is found almoſt a ſure, though not ſo ſpeedy a remedy of the ſpurious, if properly applied.

Intermitting fever is that, which ceaſes and returns again alternately, at ſtated periods, called alſo an *ague*.

In this kind, cold and heat, ſhivering and ſweat, ſucceed each other.

Symptoms of an intermitting fever. The paroxiſms are attended with ſickneſs, nauſea's, vomitings, head-ach, pain in the back and loins, *&c.* The paroxiſms are acute, but the diſeaſe uſually more or leſs chronical.

Prognoſtick. No body was ever killed of an intermitting fever, except in the firſt ſtage of the paroxiſm, during the ſhivering, cauſed by the oppreſſion of the ſpirits. When the diſeaſe becomes of a very old ſtanding, it ſometimes degenerates into other fatal ones.

Cure of the intermitting fever. As to the cure, it is found by abundant obſervations, that neither bleeding nor emeticks, nor cathartick, nor any other remedy adminiſtered during the fit, avail any thing. A juſt doſe of vinum benedictum, three hours before the paroxiſm, *Morton* aſſures us, has often cured it: antimonium diaphoreticum, a little before the paroxiſm, has the like effect: and ſalt of wormwood is commended on the ſame occaſion. *Dolæus* mentions lapis lazuli, taken in ſpirit of wine before the fit, as admirable.

And ſeveral bitters, as cardus benedictus, gentian root, camomile flowers, pulvis febrifugus, *&c.* were much valued before the invention of the *bark*; which, by the general conſent of phyſicians, is allowed a ſpecifick for intermitting fevers, in all ſeaſons, ages, and conſtitutions.

Intermitting fevers are of divers kinds, as the *Quotidian fever*, where the paroxiſm returns every day. *Double quotidian*, which returns twice in twenty-four hours.

Tertian fever, which only returns every other day; which again is either *legitimate* or *ſpurious*. The *legitimate tertian* only holds twelve hours, and is followed by an abſolute intermiſſion. The *ſpurious tertian* exceeds twelve hours, and ſometimes holds eighteen or twenty.

Double tertian is that which returns twice every other day. The name *double tertian* is alſo uſed where the fever returns every day, like a quotidian, only at different times of the day; the third fit anſwering to the time of the firſt, the fourth to that of the ſecond, *&c.*

Quartan fever is that which only returns every third day, leaving two days intermiſſion between every two fits.

Double quartan is that which has two fits every fourth day. The ſame is alſo given to the fever which returns every two days ſucceſſively, only leaving one day's intermiſſion.

Triple quartan fever is that which has three fits every fourth day; or that which returns every day like a quotidian, only at different ſeaſons of the day; the fourth fit anſwering to the time of the firſt, the fifth to the ſecond, *&c.*

Cauſes of intermiſſion. All theſe various kinds of intermiſſions, proceed from the greater or leſſer number of obſtructions the blood meets with in its courſe; and the more or leſs time it takes in conquering them.

Laſtly, there are ſome extraordinary ſpecies of fevers, not reducible to any of the forementioned claſſes, as *malignant*, *eruptive*, and *peſtilential* fevers.

Malignant fevers are thoſe, wherein the uſual, regular ſymptoms do not appear, (nature being oppreſſed with the malignity of the febrile matter) but other foreign ſymptoms ariſe; as a pain about the ſtomach and præcordia; a livid complexion, with the face much disfigured, *&c.* ſometimes efflorescences on the ſkin, *&c.*

Some authors, from microſcopical obſervations affirm, that in all malignant fevers the blood is ſo corrupted, that ſwarms of little worms are generated therein, which occaſion moſt of the ſymptoms.

Cure of malignant fevers.——In all malignant fevers the blood is too fluid. Blood-letting has here no place. vomitories do well at firſt, afterwards ſudorificks, and alexipharmicks. Bliſters are commended in the proceſs of the diſeaſe.

Eruptive fevers are thoſe, which, beſide the ſymptoms common to other fevers, have their criſis attended with cutaneous eruptions. Such are thoſe of the ſmall pox, meazles, the petechial, the purple or ſcarlet fever, and the miliary fever.

Symptoms.—— The other ſymptoms are a grievous oppreſſion of the breaſt, laborious ſhort breath, obſtinate waking, ſpaſms, ſore throat, cough, *&c.*

Prog-

Prognoſtick.——All theſe kinds of fevers are very dangerous; and are always cured by antidotes and ſudorificks.

Peſtilential fevers are acute, contagious, and mortal diſeaſes.——Some will have the fever to be the diſeaſe, or plague itſelf; others only account it a ſymptom of the plague.

Petechial fever is a malignant fever, wherein, beſide the other ſymptoms on the fourth, or more frequently the ſeventh day, *petechiæ*, or *red-ſpots*, like flea-bites, appear chiefly on the breaſt, ſhoulder, and abdomen. The ſpots, afterwards, turn paler, then yellow, and ſo diſappear. When they grow livid, or black, they uſually prove fatal. The petechial fever is alſo called *febris lenticularis*, and *pulicaris*.

The PLAGUE, or *peſtilence*, is a very acute, malignant, and contagious diſeaſe; uſually proving mortal.

The *plague* is commonly defined by a *malignant fever*; but *Diemerbroeck* thinks the two ought to be diſtinguiſhed; the fever not being the eſſence, but only a ſymptom or effect of the plague.

Cauſes of the plague.—The origin and cauſe of the plague has been a celebrated ſubject of controverſy among phyſicians. The diſorder is generally ſuppoſed to be communicated by the air; but how, and in what manner the air becomes thus deadly, is the queſtion.—Some will have inſects the cauſe of plagues, as of blights; which being brought in ſwarms from other parts, by the winds are taken into the lungs by reſpiration, mixed with the blood and juices, and attack and corrode the viſcera.

Mr. *Boyle* attributes plagues principally to the effluvia, or exhalations breathed into the atmoſphere from noxious minerals.

Symptoms of the Plague.—The plague according to *Sydenham*, uſually begins with a chilneſs and ſhivering, like the acceſs of an intermitting fever; then comes on a nauſea, with vehement vomitings, an intenſe pain about the region of the heart, as if pinched in a preſs; and a burning fever, which continually preys on the patient, till either death, or the eruption of ſome bubo, parotis, or other tumour, in the inguina or axillæ, or behind the ears relieve him, and diſcharge the matter of the diſeaſe. Sometimes, indeed, it attacks without any fever; purple ſpots appearing all at once, the certain ſigns of preſent death: but this rarely happens, except at the beginning of ſome terrible plague. It has alſo been known to make its firſt appearance in tumours, without any fever, or other violent ſymptom.

Heavineſs, pain in the ſtomach, head and back, cardialgy, broken ſleep, anxiety, alteration in the look, difficulty of breathing, hiccough, ſyncope, delirium, convulſive twitchings, diarrhæa, eyes ſunk or inflamed, tongue black and dry, vehement drought, fætid breath, carbuncles, livid ſpots, purple, green, *&c.* are alſo ſymptoms uſually attending this diſeaſe.

Prognoſticks of the Plague.—A great deal of the prognoſtick depends on the circumſtances of the tumours, or plague-ſores: as they appear, and increaſe, the fever abates; and as they ſink, or diminiſh, renews again. When they happen about the time of the criſis, and ſuppurate kindly, they are good prognoſticks of a happy recovery.

In the terrible plague at *Nimeguen*, *Diemerbroeck*, who atttended the ſick thro' the whole progreſs thereof, relates, that thoſe taken ill about new and full moon, rarely eſcaped; that faintings, ſwoonings, and palpitations of the heart, were uſually deadly ſigns; an intermitting pulſe always mortal; drowſineſs, ſneezings, tremulous motions, doating, ſore throat, *&c.* were ill omens: pleuriſies, always mortal; coſtiveneſs a good ſign; a diarrhæa almoſt conſtantly fatal; bloody ſtools, or urines, always preſaged ill.

Cure of the Plague.—As to the cure, phyſicians are much divided. It is generally attempted by alexipharmicks and cardiacks, with the aſſiſtance either of ſudorificks, or phlebotomy, or both. Many eminent phyſicians, both antient and modern, highly commend blood-letting; *Sydenham* particularly ſays, that if uſed copiouſly, and in time, it never yet did harm, but that ſudorificks often prove pernicious: *Diemerbroeck*, on the contrary, with other very experienced writers, proteſts againſt phlebotomy, as very dangerous, and often deadly: their chief hope they built on diaphoreticks and ſudorificks, as the only means to evacuate the morbifick matter. Emeticks and purgatives are expreſly forbid: and yet Dr. *Sayer* uſed the former with good ſucceſs in the beginning of the diſeaſe in the plague at *London*, *Anno* 1640.

The juice of lemons is commended, as of ſingular efficacy in the plague, and peſtilential fevers. *Piſo* relates that it is the principal remedy of the *Indians*, and proteſts he never knew any thing come up to it. Dr. *Harris* obſerves, that the ſame is what the *Turks* have principally recourſe to. Camphire is alſo much extolled; this, *Etmuller*, aſſures us, was the baſis of *Heinſius*'s antipeſtilential oil, who had a ſtatue erected to him when dead, in the city of *Verona*, for the ſervice he had done hereby. It was prepared of equal quantity of camphire, citron bark, and amber. Viperine ſalt, and rob of elder-berries, are alſo commended.

For preſervatives againſt the plague, they are uſually ſummed up in that popular diſtich.

Hæc

Hæc tria labificam tollunt adverbia peſtem,
Mox longe, tarde, cede, recede, redi.

Cauteries, and eſpecially iſſues, and ſetons in the inguina, are found of great ſervice in preſerving from infection. A piece of myrrh, held in the mouth in contagious places, is alſo commended But *Diemerbroeck* aſſures, that there is nothing better in this intention than ſmoaking tobacco; but he adds, that it was only ſo to ſuch as had not made the practice familiar to them. The other preſervatives uſed by that author, were the *rad. beleni*, cardamoms, white wine vinegar, and chearfulneſs; and when he found his ſpirits low, as if the diſeaſes were taking poſſeſſion, a cup of generous wine, ſometimes even to a degree of ebriety.

The Scurvy is a diſeaſe very frequent in the northern countries; particularly in fenny, wet, humid places, expoſed to the north, *&c.*

Cauſes of the Scurvy. — *Charleton* obſerves, that it ariſes chiefly from ſharp, ſaline particles, taken in by inſpiration, from ſalt and corrupted meats eaten, from bad waters drank, from naſtineſs, deep chagrins, *&c.*

Symptoms of the Scurvy. — The moſt uſual ſymptoms are bleeding, coughing, vomitting, difficulty of breathing, looſeneſs, a relaxation of the parts, ſweating, a fætid ſmell of the gums, a falling of the teeth, ſtinking breath, reddiſh or yellow livid ſpots, pains of the arms and legs, wearineſs, faintings, lazineſs, head-ach, *&c.*

Prognoſtick of the Scurvy. — A confirmed ſcurvy is always very dangerous; eſpecially when the perſon afflicted therewith, indulges that inaction, or indolency inſeparable from it, and neglects keeping himſelf very clean.

Cure of the Scurvy. — The cure is very difficult; and when the diſeaſe is rooted next to impoſſible. It ſometimes goes off in a flux by ſtool, ſometimes by the hæmorrhoides, and ſometimes by urine; but more often degenerates into a dropſy, atrophy, apoplexy, epilepſy, or convulſions.

A very exact diet is held of more effect than the beſt medicines; without this it becomes incurable. Bleeding does not avail; ſtrong purgatives are hurtful: ſo is ſugar and all ſugar'd things. *Mercurius Dulcis* uſed inrernally, ſo as not to ſalivate, but only raiſe a ſweating, is found excellent. *Dolæus* undertakes to cure any *ſcorbutus* in twelve days time, by the uſe of this alone; only the patient to drink nothing at all times but a proper decoction, and to abſtain from acids and hog's fleſh. *Charleton* recommends a continued uſe of milk, particularly milk emulſions of ſweet almonds, decoctions of china, broths, and other anti-acids and analepticks. — *Etmuller* makes the baſis of the cure of the *ſcorbutus*, and hypochondriacal diſeaſe, the ſame, *viz.* copious vomiting; ſtrong catharticks, he obſerves, are prejudicial; but gentle ones good; for the body is to be ſtill kept open. He adds, that vinegar is hurtful, and yet the acid juices of fruits and vegetables wholeſome. Accordingly the uſe of lemon-juice is much recommended by *Liſter*. Milk, and all milky things, while the ſtomach is yet able to digeſt, are excellent; ſo are mercurials. — *Etmuller*, inſtead of mercurials, recommends antimonials.

Thus much in general. — For the particular ſymptoms, particular medicines adapted thereto are to be uſed, only mixing antiſcorbuticks with them all.

The chief ſimple antiſcorbuticks are, horſe-raddiſh, ſorrel, butter-bur, ſcorzonera, ſow-thiſtle, zedoary, polypody, elecampane, guaiacum, ſaſſafras, muſtard-ſeed, (which is the beſt of all) naſturtium aquaticum, trifolium paludoſum, oranges, lemons, juniper-berries, cream of tartar, tartarum vitriolatum, *&c.*

Boerhaave preſcribes the following remedies for the ſcurvy,

Vomitives. — Take tartarum vitriolatum, cream of tartar, and ſal polychreſte, of each half a drachm; mix them together for a powder, which ſhall be taken in a pint of whey, in the morning; the patient drinking afterwards twelve ounces of whey.

Attenuant and *digeſtive remedies.* — A drachm of the tincture of ſalt of tartar of *Van Helmont*, made with two ounces of wine.

A drachm of the tincture of mars of *Ludovicus*, with an ounce of wine.

The ſalts of the vegetables of *Tachenius*, with three ounces of wine.

Two drachms of elixir proprietatis with vinegar, *&c.*

The Evil, or *king's-evil*, is a diſeaſe called in medicine, *ſtrumæ* and *ſcrophulæ*, conſiſting in ſcirrhous tumours, ariſing moſt commonly about the neck, but ſome alſo on the other glandulous parts, as the breaſt, arm-pits, groin, *&c.*

Cauſes of the king's-Evil. — The cauſe of the king's-evil is a thick and viſcous limpha, extravaſated in the ſubſtance of the glands, and renders them imbecil towards the ſecretion of the ſerum.

The king's evil is a contagious malady, and is propagated from father to ſon, and from generation to generation; therefore it is conſidered in *France* as an impediment to matrimony; ſo that a marriage contracted, where either of the contracting parties is attainted with that diſtemper, is declared null by the laws of that realm.

The *king's evil* is a diſeaſe very rebellious to all ſorts of remedies, eſpecially when rooted in,

and

and it is but very ſeldom that patients are thoroughly cured.

DISEASES *of the* ABDOMEN. The *hypochondriack* is a very comprehenſive diſeaſe.

When conceived, as is ſituate in the hypochondriack regions, or ariſing from ſome diſorder of the parts contained therein, *viz.* the ſpleen, liver, *&c.* it is properly called the *hypochondriacal diſeaſe*, *ſpleen*, &c.

When conceived as owing to ſome diſorder of the womb, it is called *hyſterick affection*.

And laſtly, when the flatulent rumblings in the inteſtines, belchings, *&c.* are conſidered, it is called the *vapours*.

Cauſes of the Hypochrondriack. — The ſeat of this diſeaſe is commonly ſuppoſed to be in the animal ſpirits, and the nervous ſyſtem. Its cauſe is referred to an acid ſalt abounding in the maſs of blood; to which the ill diſpoſition of the ſtomach, and the other parts contained in the epigaſtrium, may greatly contribute. *Purcel* aſſigns crudities and indigeſtions as the prime cauſe, and in that he is not at all miſtaken. According to *Sydenham*, vehement motions of the body, or more uſually violent perturbations of the mind, as grief, anger, fear, *&c.* are its procatarctick cauſes.

Symptoms of the Hypochondriack. — Its ſymptoms are very numerous; the moſt uſual are a pain in the ſtomach, windineſs, vomitings, a ſwelling or diſtention of the *hypochrondriums*, or upper part of the belly, noiſe and rumblings in the lower venter, wandering pains, a conſtriction of the breaſt, difficulty of breathing, palpitation of the heart, faintings, watchings, inquietudes, ſwimming of the head, fear, ſuſpicions, melancholy, deliriums, *&c.* Not that all theſe accidents befall always every perſon afflicted with this diſeaſe; but ſometimes ſome of them, and others at other times, according to the conſtitution, *&c.* of the patient.

In effect, the hypochondriacal is a very vague indeterminate ſort of diſorder. Dr. *Sydenham* obſerves, that its ſymptoms ape or emulate thoſe of moſt other diſeaſes; and that whatever part it is in, it produces ſomewhat like the common diſeaſe of that part. Thus in the head it produces a ſort of apoplexy, fits like to epilepſy, called hyſterick fits, intolerable head-ach, *&c.* In perſons affected with the *choloroſis*, it produces a palpitation of the heart; ſometimes, though rarely, it ſeizes the lungs, and cauſes a continual dry cough: it alſo imitates the cholick and iliack paſſion, and ſometimes the ſtone, jaundice, *&c.* In the inteſtines it produces a diarrhæa; in the ſtomach nauſea's. Sometimes it ſeizes the external parts, and particularly the back, which it renders chilly and painful; and the legs and thighs, which it ſwells ſo as to reſemble the dropſy: ſeizing the teeth it reſembles the ſcurvy, (indeed *Etmuller* makes the ſcurvy itſelf to be a great degree of this diſeaſe.) Laſtly, which is the moſt unhappy circumſtance of all, the patient is more affected in mind than in body.

Prognoſtick. — The hypochondriack is a very common and obſtinate diſeaſe; and as it proves rebellious to almoſt all ſorts of remedies, it teazes both the patient afflicted therewith, and the phyſician who undertakes the cure thereof; and though it proves very ſeldom mortal, it notwithſtanding moſt commonly accompanies the patient to the grave.

Cure of the Hypochondriack. — Adviſing the patient to be chearful, and to avoid all that can cauſe him the leaſt uneaſineſs, as chagrin or melancholy; order the uſe of the half-bath, to repair the tone of the ſtomach, and to procure a good digeſtion of the aliments; then try firſt, by gentle purgatives, to evacuate the morbifick matter both by ſtool and urine; and forbid the uſe of all ſorts of aliments, which are not of a very eaſy digeſtion: next preſcribe ſtomachicks, reſtoratives and cephalicks; and conclude by remedies to purify the maſs of blood; preſcribing beſides a moderate exerciſe.

The *hyſterick* is, as already obſerved, a ſpecies of the *hypochondriack*, peculiar to women, and ſuppoſed to ariſe from ſome diſorder of the womb.

Cauſes of the Hyſterick. — The ordinary cauſes of this diſorder are violent paſſions, rage, love, grief, bad news, ſweet ſmell. The real cauſe being in the animal ſpirits, and the nervous ſyſtem.

The more common ſymptoms or accidents of this diſeaſe, are a ſwimming of the head, dazling of the eyes, inquietudes, pains of the abdomen, belches, nauſeas, vomitings, deliriums, convulſions. It is not always attended with all theſe ſymptoms, but ſometimes with more, and ſometimes with leſs, and thoſe more or leſs violent.

Baglivi adds, that hyſterick women feel a ſenſe of cold in the crown of the head; and this he takes to be the chief diagnoſtick of the diſeaſe.

Prognoſtick. — This malady proves very ſeldom mortal, but it is a very obſtinate one, and rebellious to almoſt all ſorts of remedies, eſpecially as to a perfect cure thereof.

Cure of the Hyſterick. — During the paroxiſm fetid things, whether internally or externally applied, are of advantage, particularly *caſtoreum*, the ſmoak of burnt horn, or burnt feathers held to the noſe. Volatile ſpirits alſo help to awake the patient out of the paroxiſm; as alſo tickling in the ſoles of the feet. Where it is ſeverer than

ordinary, recourse must be had to puncture, scarification, vesicatories, caustick, &c.

The Clorosis (which signifies *greenness*, *verdure*, from the *Greek* χλοη, *grass*) is a feminine disease, vulgarly called the *green-sickness*, &c.

Its usual subjects are girls, maids, and widows; and even wives, whose husbands are deficient, &c.

Causes of the Clorosis. — This disease comes on commonly antecedent to, or about the time of the eruption of the menses. Though the stoppage of the menses is not always the cause of this distemper; for they sometimes flow regularly, though but seldom, in the progress thereof. — According to *Etmuller*, the suppression of the menses are rather the effect than the cause. I rather attribute the cause of this disease to an effrenate desire of the act of venery, which generate a plenitude in the spermatick vessels, which for want of evacuation, acquire a preternatural quality, which sends putrid vapours into the mass of the blood, which infects it, and renders it very slow in its circulation.

Symptoms. — This disease gives a pale, yellow, or greenish tincture to the complexion, with a circle of violet under the eyes. — The patient is melancholy, and uneasy; has frequently a low wandering fever, with an unequal pulse, vomiting, heaviness, listlessness, drowsiness, difficulty of breathing, longing for absurd foods, &c.

Prognostick. — This malady is much more troublesome than dangerous.

Cure of the Chlorosis. — The most specifick remedy for this disease is the human coition; tho' it is chiefly attempted by bleeding in the foot, chalybeates, and bitters. In the colder constitutions, decoctions of guaiacum are found of use.

The Jaundice (from the *French jaunisse*, yellowness, or *jaune*, yellow) is a disease consisting in a suffusion of the bile, and rejection thereof to the surface of the body, whereby the whole exterior habit is discolour'd.

Causes of the Jaundice. — There are three kinds of *jaundice*. The first, properly called the *jaundice*, or *yellow jaundice*, is owing to the yellow bile, which, in this case is too exalted, or too abundant in the mass of the blood; or perhaps to an obstruction of the glands of the liver, which prevents the gall being duly separated from the blood; or to a stoppage of the porus bilarius, or the like means, whereby the mixture of that fluid with the aliment in the intestines is prevented.

The second, called the *black jaundice*, is owing to the same bile being mingled with acids.

The third, bordering on green, takes its rise also from a mixture of bile with an acid.

Diagnostick. — In the *yellow jaundice*, the *albuginea*, or white of the eye, and the skin, are chiefly yellow; and besides troubled with an itching. In the *black jaundice*, the natural colour is lost, by reason of an atrabiliary humour, spread underneath the skin: it first appears brownish, and afterwards of a lead-colour.

Prognostick. — The jaundice often proves a forerunner of the dropsy. — The *black jaundice* is incurable, especially in men advanced in years; who when afflicted with it, must prepare for the other world.

Cure. — The acid spirit of sal ammoniack, is said to be an excellent remedy against the jaundice.

The Dropsy is a preternatural collection of *serum*, or water, in some part of the body; or a too great proportion thereof in the blood.

The *dropsy* acquires different names from the different parts it afflicts, or the different parts the waters are collected in.

That of the abdomen, or lower belly, called simply and absolutely *dropsy*, is particularly denominated *ascites*. — That of the whole habit of the body, *anasarca*, or *leucophlegmatica*. — That of the head, *hydrocephalus*. — That of the scrotum, *hydrocele*.

There is also a species of this disease supposed to be caused, instead of water, by a collection of wind, called *tympanites*; and by *Hippocrates*, *dry dropsy*. — We also meet with dropsies of the breast, pericardium, uterus, ovaries, &c.

Causes of Dropsy. — The causes of dropsy in general, are whatever may obstruct the serous part of the blood, so as to make it stagnate in the vessels; or burst the vessels themselves, so as to let the blood out among the membranes; or weaken and relax the tone of the vessels; or thin the blood, and make it watery, or lessen perspiration.

These causes are various, *viz.* sometimes acute diseases, scirrhous tumours of any of the more noble viscera, excessive evacuations, particularly hæmorrhages, hard drinking, &c.

Symptoms of the Dropsy. — The *ascites* or water-dropsy of the abdomen, is the most usual case, and what we particularly call the dropsy. Its symptoms are tumours, first of the feet and legs, and afterwards of the abdomen, which keeps continually growing; and if the belly be struck or shook, there is heard a quashing of water. Add to this three other attendants, *viz.* a dypsnæa, intense thirst, and sparing urine; with which may be number'd heaviness, listlessness, costiveness, a light fever, and an emaciation of the body. — *Baglivi* notes, that in a dropsy arising from a morbid liver, there is always a vehement dry cough, which is never observed in the other cases.

Prognostick.

Prognoſtick.—The dropſy is always a dangerous diſeaſe, and though cured in appearance, for ſome time, returns again, and kills the patient at laſt. *Tycho Brahe* notes, that hydropick perſons uſually die about full-moon.

Cure of the Dropſy.—The curative indications are two, *viz.* the evacuation of the water, and the ſtrengthening of the blood and viſcera. The firſt is effected by ſtrong purgatives, particularly elaterium, and the infuſion of crocus metallorum, though this laſt works upwards more than downwards. For ſuch as are too weak to bear purgatives, Dr. *Sydenham* recommends diureticks, whereof the beſt are thoſe made of lixivial ſalts.

For the ſecond intention, exerciſe and change of air, wine, and other generous liquors, alſo ſtomachicks, chalybeates, and other corroborating medicines are preſcribed.

Where other means fail for evacuating the water, recourſe is had to the paracenteſis, or operation of tapping, deſcribed in the Treatiſe of *Chirurgery*.

Mayern recommends *mercurius dulcis*, and nitre, and ants eggs, for the promoting of urine, and draining the tumour. Exerciſe, and change of air, wine, and other generous liquors cautiouſly taken, have alſo their uſe. *Wainwright* extols an infuſion of green tea in rheniſh wine; as alſo briony juice, as excellent in this diſeaſe; ſome commend garlick. The millepedes are alſo an excellent remedy.

Boerhaave preſcribes the following remedies: take the root of imperatory, *ariſtolochiæ longæ*, & *rotundæ*, zedoariæ, ſileri montanæ, of each an ounce: ſix drachms of ginger; two ounces of the ſummits of little centaury; an ounce of roſmarin; bays and juniper berries, of each an ounce and a half; thyme and ſerperlium, of each an ounce; the ſeeds of wormwood, and of tanzy, of each an ounce; pounded together to make a ſubtile powder; then take ſix ounces of that powder, and four pints of the beſt *French* wine; to make of them a medicinal wine; of which the patient ſhall drink two ounces four times a day, with the precaution of having his ſtomach empty before he takes it.

The ANASARCA is a ſort of univerſal dropſy, wherein the whole ſubſtance of the body is ſtuffed or bloated with pituitous humours.

The *anaſarca* is the ſame, with what is otherwiſe called *leucophlegmatica*.

Cauſes of the Anaſarca—It may be either owing to ſome diſorder of the blood, which in this diſeaſe is of a pale colour, viſcid and cold, or to an aqueous humour extravaſated, and gather'd together in the muſcles and the pores of the ſkin.

Symptoms.—In an *anaſarca* the legs ſwell at the beginning, eſpecially towards night, and then pit remarkably: the urine is pale, the appetite decays; at length the ſwelling riſes higher, and appears in the thighs, belly, breaſt, and arms. The face becomes pale and cadaverous; the fleſh ſoft and lax; a difficulty of reſpiration comes on, attended with a ſlow fever.

Prognoſtick.—This diſeaſe is extremely dangerous, and always mortal in perſons advanced in years.

Cure.—The remedies uſed in the *aſcites* or water-dropſy, are uſed in this; but ſeldom with any ſucceſs.

The TYMPANY is a flatulent tumour, or ſwelling of the abdomen or belly, very hard, equable, and permanent; whereby the ſkin is ſtretched ſo tight, it gives a ſound like that of a drum.

Cauſes of the tympanites.—Some are of opinion that wind certainly makes a principal part of the morbid matter; but this is ſcarce ever found without water, excepting at the beginning; ſo that ſome will not allow of any difference between the *tympany* and the *aſcites*.

Some ſuppoſe it to ariſe from a watery humour extravaſated and rarefied into vapour; and by a property common to it with common air, corrupting the parts. But this *Boerhaave* makes a particular kind of tympanites, or windy dropſy; and adds, that it is cured like the *aſcites*, or watery dropſy, by tapping, *&c.*

Others will have the *tympanites* to ariſe from the air inſinuating itſelf through perforations in the putrified inteſtines. A tympanite from this cauſe, *Boerhaave*, who makes it a peculiar claſs, obſerves, is almoſt always incurable.

Symptoms.—The ſymptoms of the *tympanites* are an exceſſive tenſion of the abdomen, an irregular and hard pulſe, frequent head-ach, *&c.*

Prognoſtick.——The tympanites rarely kills of itſelf; but it almoſt always accompanies the patient to the grave, or degenerates into an *aſcites*.

Cure—Catharticks rather aggravate than alleviate this diſeaſe: antihyſtericks, antiſcorbuticks, chalybeates, and ſtrengthners are of uſe, before it be commenced an aſcites. Equal quantities of leek and elder leaves mixed analytically, is a famed empirical medicine, which has often proved effectual, when every thing elſe had failed.

It is uſual to apply carminatives to the belly, as the emplaiſter of cummin-ſeeds, *&c.* and alſo to uſe carminatives mixed with catharticks, diureticks, *&c.* internally.

COLERA MORBUS is a ſudden overflowing oreruption of the bile, or bilious matters, both upwards and

downwards. It has its name either from the great quantity of choler it evacuates, or becauſe the matter is inceſſantly expelled at the inteſtines, which they antiently called *choladæ*.

Cauſes.—It is ſuppoſed to have its riſe from the great abundance of bilious humours; which being very acrimonious, vellicate the membranes of the ſtomach and inteſtines; and by that means occaſion unuſual and violent contractions. Dr. *Sydenham* obſerves, it generally attacks about the latter end of ſummer, and proceeds not unfrequently from ſurfeits.

Prognoſtick.—The *cholera morbus* is very dangerous; it carries off the patient in a very ſhort time.

Cure.—Dr. *Sydenham* ſays, that the cure depends upon large quantities of chicken-broth, drank ſo as to excite vomiting plentifully; and that the broth is alſo to be injected clyſter-wiſe. He adds, that the cure is to be compleated by laudanum given at proper intervals, and in proper doſes.

The remedy in the *Indies* for the *cholera morbus*, or *mandechin*, is to keep the patient from drinking, and to burn the ſoals of his feet.

Another method in the cure of the *cholera morbus* is to begin by preſcribing a doſe of ipecacuanha; and when that remedy has done operating, to order ſome ſpoonfuls of mutton-juice, in balneo mariæ, and adminiſtered to the patient by intervals; and at night a few drops of laudanum. Preſcribe likewiſe clyſters made of a ſheep's head, wool and all; to which add a few drops of laudanum.

Dysentery is a bloody *diarrhœa*, or a flux of blood by ſtool, attended with pain and griping.

The word *dyſentery* is formed from the *Greek* δυς, *difficulty*, and ἐντερον, *inteſtine*; and properly ſignifies that kind of flux of the belly, characteriſed by the frequency of ſtools, or dejections, mixed with blood, and accompanied with gripes: the fever, ulcer, *&c.* which attend it, are not eſſential to the diſeaſe; though many, both of the antient and modern, think the ulcer is.

Cauſes of the dyſentery.—Phyſicians aſſign ſeveral cauſes of the *dyſentery*, *viz.* the next, ſecond, mediate, and remote cauſes.

The next cauſe of the dyſentery is a ſerous, or other morbid humour, mixed with the maſs of blood; the conſequence of which is a too great fermentation in the blood, and a diſſolution of its parts, which are thus render'd too liquid.

The ſecond caſe is a vellication, and irritation of the nervous fibres of the inteſtines, occaſioned by ſharp, acid humours, ſeparated from the blood; which occaſion the ſpiral fibres that produce the periſtaltick motion of the guts to move too faſt, and thus to expel the matters too haſtily out of the inteſtines.

The mediate cauſe is ſome foreign body adhering ſtrongly to the inteſtines, and by its ſharp points, vellicating their nervous fibres, and at length ulcerating them.

The remote cauſes are any thing that corrupt the maſs of the blood, as viſcid, and crude, ſharp juices; ill foods; autumnal fruits; grapes; new wine drunk in exceſs; poiſons; violent medicines; waters conveyed through leaden pipes; rainy weather in the ſpring, with a dry winter, and a hot ſummer.

Symptoms.—The ſeat of the diſeaſe is in the inteſtines, either the big, or ſmall, or both. When the diſeaſe is in the ſmall ones, the gripes begin long before the ſtools, and are felt about the navel; and the blood and excrements are more blended, as being longer together. When the larger inteſtines are ſeized, the pain is leſs vehement, and is felt lower, *&c.*

The *dyſentery*, *Sydenham* obſerves, begins with a chilneſs and ſhivering; which is followed by a heat; then gripings of the belly enſue, with mucous or ſanious ſtools, which, in proceſs of time, are found interſperſed with ſtreaks of blood, with vehement pain.

The ſtools are ſometimes void of blood, and yet if they be frequent and attended with gripes, and a mucous colluvies, the ſame author ſays it is a proper dyſentery. Along with the excrements, beſides a whitiſh mucoſity, frequently comes ſcrapings of the guts, in form of little ſkins.

Prognoſtick.— The *dyſentery* is always a very dangerous diſeaſe; but much more ſo, if pure blood be evacuated, for then the patient's life is in great danger; and likewiſe when the dejections, or ſtools, have a cadaverous ſmell.

Cure.—The ipecacuanha is excellent on this occaſion: not ſo much as a vomitary, Dr. *Freind* obſerves, as a ſudorifick; having this faculty, beyond all other emeticks, that it corrects the dyſenterick ferment, in proportion as it evacuates it. In the *Philoſophical Tranſactions* we have an expreſs diſcourſe on the ſubject; where it is aſſerted to be infallible in all dyſenteries and looſeneſſes, how dangerous and inveterate ſoever; except in pulmonick and hydropick patients, whoſe fluxes are indications of approaching death.

Sydenham orders phlebotomy; but *Willis* ſays, no evacuation is good; and preſcribes hot cardiacks; as ſpirit of wine a little burnt, *&c.* Balſamick and ſtyptick medicines are alſo to be uſed, according to the divers cauſes and ſymptoms of the diſeaſe.

Barri, in a letter to *Bartholine*, affirms, there is no

no better medicaments in a dyſentery than roſe-water, wherein gold has been extinguiſhed.

Delæus relates, that he cured above a hundred perſons with oil of ſweet almonds, mixed with orange juice.

Purgatives have rarely any good effect in dyſenteries, as increaſing the fermentation of the blood, and irritating the fibres of the inteſtines more and more. Nor are emeticks much better; as tending to draw the peccant humours into the ſtomach, or at leaſt into the higher inteſtines, and cauſe more frequent ſtools.

DIARRHŒA is a looſeneſs, or flux in the belly; or a profuſe evacuation of liquid excrements by ſtool. The word, in the general, is uſed for any kind of flux of the belly; but properly for that wherein the humour or excrement flows out either pure, or mixed with, or without pain, in a fluid ſtate.

Diarrhœa's are of divers kinds, according to the diverſity of the excrements: ſome being bilious; ſome pituitous, and ſome purulent.

Cauſes.—The *purulent diarrhœa* always ariſe from ſome abſceſs open'd in the body; the reſt, either from morbid humours, irritating the inteſtines, and expreſſing the juices out of the adjacent parts; or from a laxneſs of the inteſtinal fibres; or an extraordinary fermentation in the blood, whereby it diſcharges its excrements into the inteſtines.

Prognoſticks.—Diarrhœa's, where the ſtools are very frequent, and of an inſupportable cadaverous ſmell, are always dangerous.

Cure.—In the cure of diarrhœa's, from whatever cauſe they ariſe, the ſtomach muſt be corroborated, and ſudorificks to be mixed with abſorbents. The patient to drink ſparingly. Quince and wine burnt with aromaticks is good. *Wainwright* obſerves, that a flannel ſhirt contributes much to the cure of an habitual diarrhœa.

LIENTERY is a kind of looſeneſs, wherein the food paſſes ſo ſuddenly through the ſtomach and guts, as to be thrown out by ſtool, with little or no alteration.

Cauſes.—The *lientery* is generally owing to a defect in the ferment of the ſtomach, or to a relaxation of the pylorus, attended with ſo briſk an irritation of the fibres of the ſtomach, that inſtead of retaining the aliment it lets it paſs. Exceſs of drinking ſometimes occaſions this diſeaſe by relaxing the ſtomach, and eſpecially the pylorus, too immoderately.

Symptoms.—Thoſe afflicted with this diſeaſe, have always a little fever, with a ſudden chilneſs ſeizing them all over ſeveral times in a day. The motion to go to ſtool is ſo quick and ſo violent, that they cannot ſtop it for any ſpace of time.

Prognoſtick.—This malady is more troubleſome than dangerous; though it moſt commonly accompanies the patient to the grave, for it is not only almoſt incurable, but it is even often very dangerous to cure it.

COLICK is a ſevere gnawing pain, felt in the lower venter, ſo called becauſe the ordinary ſeat of the diſorder was antiently ſuppoſed to be in the inteſtine colon.

We uſually diſtinguiſh three kinds of *colick*, the *bilious*, *windy*, and *nephritick*.

Cauſe of the bilious colick.—The *bilious colick* has its riſe from certain ſharp, bilious, ſtimulating humours, which being diffuſed through the inteſtines, vellicate their fibres, and occaſion a ſenſation of pain.

Symptoms.—Dr. *Sydenham* obſerves, that the bilious colick uſually attacks about the beginning of ſummer; that it is generally attended with a vomiting of bilious green liquor; that the patient complains of exceſſive heat, great gripings, faintneſs, *&c.*

Prognoſtick.——*Sydenham* is of opinion, that if the bilious colick be not ſoon remedied it is apt to turn into the *iliack paſſion*. And *Baglivi* notes, that if the patient ſweats much, and be much enfeebled, the diſeaſe is apt to degenerate into a palſy.

Cure.——The cure, *Baglivi* ſays, depends on bleeding, gentle catharticks, and clyſters: and if it ariſe from a crapula, an emetick is to precede; after which the cure is to be compleated by proper anodynes.

Wind-colick is vagabond, never ſtaying in any fixed place, being produced by windy vapours, which ſwell and diſtend the inteſtines they are incloſed in.

The *nephritick colick* is that, felt uſually in the reins whence it has its name.

Cauſe of the nephritick.——It has uſually its riſe from ſome ſtone or gravel detached from the kidneys, and fallen into the pelvis.

Symptoms.——The *nephritick* is always attended with violent reachings and vomitings, and an exceſſive heat, in the region of the loins.

Prognoſtick.——The nephritick is a very painful diſeaſe, and is alſo very dangerous.

Cure for all ſorts of colicks.——In colicks ariſing from flatulencies, carminative waters, oils, aromaticks, *&c.* are always to be added to the compoſitions: —— and in nephritick colicks, beſides emollient clyſters, ſolutions of manna, cremor tartari, *&c.* in whey, *&c.* and proper oleaginous mixtures are to be exhibited to relax the fibres; after which proper anodynes take place. In a fit of the nephritick, the firſt remedy I preſcribe to eaſe the patient is, oil of ſweet almonds, ſyrup of marſh mallows and lemons, of each half an ounce;

and

and an ounce of water of parietary, mixed together for a doſe.

Baglivi recommends camomile as an antidote againſt the colick, from what cauſe ſoever it ariſe. Where the diſeaſe is obſtinate, much riding has been found of eſpecial ſervice.

The Iliack Passion is a violent kind of colick; called alſo *volvulus*, *miſerere*, and *cardapſus*.

Cauſes of the iliack paſſion.——The immediate cauſe of the *iliack paſſion* is owing to an irregularity or inverſion of the *periſtaltick* motion of the guts, *viz.* when it begins with the lower, and is continued upwards; which irregular motion is called *antiperiſtaltick*; and is occaſioned by the hardneſs of the excrements, which obſtructs the paſſage through inflammation of the inteſtines, and their engagement in the *anus* or *ſcrotum*, as ſometimes happens in *hernias*.

Symptoms.——Perſons afflicted with this diſeaſe expel the feculent matter by the mouth, which expulſion is accompanied with a ſwelling and tenſion of the abdomen, an intenſe pain, and a total conſtipation.

Prognoſtick.——The *iliack paſſion* is a very dangerous malady; which requires immediate relief; otherwiſe it carries off the patient in a very ſhort time.

Cure.—Some have been cured of this diſeaſe, by ſwallowing a great quantity of quickſilver, or a muſket ball, or a ball of regulus of antimony. The following pills are a good remedy for the iliack paſſion: Take eight grains of troches of alhandel, three grains of diacyrdium, and eight grains of ſagapenum; mixed together in the juice of leeks, for a doſe of pills; which may be repeated if the diſeaſe continues.

The Stone is a diſeaſe, called alſo *calculus*, and *lithiaſis*, and occaſionally the *gravel*. It conſiſts of a ſtony concretion, formed either in the bladder or kidneys; which prevents the diſcharge of urine, and occaſions violent pains.

I attribute the generation of the ſtone to a viſcid or ſlimy matter, ſeparated from the urine in the pelvis; and which being too thick to be uſhered through the ureters along with the urine, adheres to the pelvis, where it is condenſed by the exceſſive heat of the kidneys, increaſed by the efforts it makes to unload itſelf of that foreign body; and where it grows in bulk by the new acceſſion of the like ſlimy matter, the quantity thereof augments in proportion, as the pelvis grows more weak in its natural functions.

The ſtone in the bladder is firſt formed in the pelvis of the kidneys; whence falling into the bladder it becomes augmented by new *lamellæ*, or coats.

Symptoms of the ſtone in the kidneys.—The ſymptoms of the ſtone in the kidneys, are, 1. A fixed obtuſe pain in the region of the loins, appearing like a weight loading the reins. As the ſtone falls out of the *pelvis* into the ureter, the pain is exceedingly acute and racking, which holds till either the ſtone be got into the bladder, or returned again into the pelvis.——2. An inflexibility of the *ſpina dorſi*, from the extenſion and compreſſion of the nerves.——3. A ſtupor of the thigh and leg of that ſide, from the conſent of parts.——4. A retraction of the teſticle.——5. A very ſmall quantity of urine, either thin and limpid, or bloody. But as ſoon as the ſtone is got into the bladder, the urine becomes thick, turbid, blackiſh, and in great quantity.

Symptoms of the ſtone in the bladder.——The ſymptoms of the ſtone in the bladder, are a ſenſe of heavineſs in the *perinæum*, and *inguinal* region, a perpetual and troubleſome deſire of making water, which is followed with a ſharp pain, particularly in the *glands* of the *penis*, whence a *prolapſus* of the *anus*. But the ſureſt way of finding it is by the touch, *viz.* by thruſting the finger or a *catheter* up the *anus*.

Prognoſtick.—The ſtone, both in the kidneys and bladder, but more particularly in the kidneys, is a very cruel malady; which, though it does not kill always the patient, but keeps him languiſhing for ſeveral years in the moſt excruciating tortures, makes him notwthſtanding wiſh often for death, to finiſh his miſeries.

Cure of the ſtone.—The cure of the ſtone is either by ſome medicines, which will diſſolve or break the concrete ſtone; ſo that it may be evacuated by piece-meal, which is called a *lithonthriptick*, or by enlarging the capacity of the veſſels; or by the operation of cutting, called *lithotomy*; which operation is deſcribed at large in the treatiſe of *Chirurgery*.

Deckers recommends calcined egg-ſhells, as excellent in all ſuppreſſions of urine; *Hamilton*, linſeed oil; and Mr. *Boyle*, the herb arſemart.

From the maladies of the abdomen or lower venter, I'll paſs to thoſe which affect the extremities of the body.

Diseases of the Extremities.

The Gout is a painful diſeaſe, occaſioned by a flux of ſharp humours, upon the joints of the body.

Some phyſicians define the *gout*, an inflammation, ſwellings, and painfulneſs of the joints.

Cauſes

Cauſes of the gout. ——The gout is ſuppoſed to ariſe from a redundancy of humours, and a weakneſs of the joints. Its proper ſeat is in the limbs, not in the trunk of the body: in the latter caſe it frequently proves mortal, not in the former.

According as different parts are affected by this diſtemper, it goes by different names. When it ſeizes the feet, it is called *podagra*. When the knees, *genagra*. When the hands, *chiragra*. And when the hip-joint, *ſciatica*, &c. Sometimes it attacks the whole body at the ſame time, and then it is called the *general* and *univerſal gout*.

The gout may be hereditary or natural to the conſtitution, proceeding from a too great conſtriction of the capillary veſſels, whence the gouty humour is more eaſily lodged, and detained in them. It may alſo proceed from high living, crapula's, and eating ſuch things as are hard of digeſtion; a ſedentary life; drinking too freely of tartarous wines; irregular living; exceſs in venery; an obſtructed perſpiration.

Some are of opinion, that the immediate cauſe of the gout, appears to be an alkaline or acrimonious matter in the blood; which being ſeparated from it, at particular times, falls upon the joints, but moſt frequently upon the feet and hands; which if it be repelled, or if the blood be overcharged therewith, ſo that a criſis cannot be procured in the extremities (as generally happens in old age) it falls upon the nobler parts.

My ſentiment is, that the immediate cauſe of the gout is a kind of vitriolick ſalt, uſhered into the maſs of the blood, by a bad coction of the aliments; but which at firſt is in ſo ſmall a quantity in the whole maſs, that it produces none of thoſe bad effects, which could be expected from it, as a coagulum, *&c.* its being continually volatilized by the native heat, and kept in a continual motion by the rapidity of the circulation, till that native heat being much abated, and the circulation becoming much ſlower towards the extremities; that ſalt loſing thereby its motion, falls by its own weight on thoſe parts, and corrode the tendereſt thereof, ſuch as the articulations; whence enſues, that excruciating pain felt in the paroxyſm, and which continues, till nature, in the convulſions excited thereby, calls the animal ſpirits to the ſuccour of the afflicted part, which following the natural impulſe, crowd thither; and by the exceſſive heat, they cauſe in the part, by their continual rotation, exalt once more thoſe ſaline particles, and expel the greateſt part thereof by perſpiration; but as thoſe cannot force their way through the fleſh, without cauſing ſome diſorders in the mechaniſm of the fibres, by their acuteneſs and ſharpneſs, hence enſues the ſwelling of the part.

The gout is either regular or irregular.—Regular, when it appears to be ſeated in the extremities of the body, returns at ſtated periods, and with a gradual increaſe, and decline of the ſymptoms. Irregular, when the paroxyſms are frequent and uncertain; when the ſymptoms vary, and happen promiſcuouſly, and the diſeaſe appears to be ſeated in the internal parts of the body; as the ſtomach, brain, *&c.* leaving the extreme parts, as the hands, feet, *&c.* free from pain.

Symptoms of the regular gout.—The regular gout, chiefly and immediately affects the tendons, nerves, membranes, and ligaments of the body about the joints. Sometimes a cold ſhivering fit precedes, and generally a fever accompanies its firſt appearance, which ſoon goes off, and returns by intervals. A ſlight pain is felt in the joints, where the criſis is performed, which increaſes gradually; and in the *podagra*, generally fixes firſt on the great toe; then proceeding to the *tarſus* and *metatarſus*; ſometimes, eſpecially in old age, it attacks the knees and hands; and wherever it is, by wounding and corroding the part, cauſes a violent pain, not unlike that of a diſlocated bone. When the pain is at its ſtate, *i. e.* while the native heat is working to exalt and expel the ſaline particles, which cauſe it, there appears an inflammation and ſwelling; both which increaſe, as the pain decreaſes; and upon their remiſſion, the paroxyſm is ended; tho' the tenderneſs and ſwelling, in ſevere fits, will ſometimes remain a longer time, and cauſe an uneaſineſs upon motion.

The pain increaſes towards night, and decreaſes towards the morning; the longer the intervals between the paroxyſms, the more ſevere they prove, and the longer they generally continue; becauſe there is then a greater quantity of the morbifick matter gather'd in the neighbourhood of the part; which is much more difficult, and takes much more time to be expelled.

The diſeaſe uſually returns twice a year, *viz.* in the ſpring and autumn; and in the latter paroxyſm, is, ſometimes, two or three months before it comes to a period: though its duration is ſometimes not above three or four weeks.

Theſe are called cardinal paroxyſms, to diſtinguiſh them from others of leſs duration, which happen between the ſpring and autumn. The more high-colour'd the urine, and the leſs ſediment it depoſits, the further is the diſeaſe from the ſtate of concoction, as it is term'd. According to the violence and continuance of the fever, the paroxyſm proves more or leſs ſevere.

In conſtitutions much broke or ſhatter'd with the gout, there are uſually ſtony or chalky concretions formed in the joints of the fingers or toes, and

thence tranſlated to the viſcera; which caſe is often attended with irregular, frequent, and ſhort paroxyſms in the extremities. In the decline of life, when the uſual fits do not happen; if the gouty matter be ſuddenly repelled from the extremities (to uſe the improper common ſtile) by an improper regimen or medicines, it uſually ſeizes the internal parts, and frequently the ſtomach, head, inteſtines, *&c.* cauſing want of appetite, reaching to vomit, indigeſtion or cachexia, the jaundice, aſthma, diarrhœa; and at laſt ſo obſtructs the fine capillary, nervous tubes (eſpecially thoſe of the ſtomach and brain) as poſſibly to hinder the flux of the animal ſpirits: upon which death ſuddenly enſues.

Sydenham gives us the hiſtory of a regular fit of the gout in the feet. It begins towards the cloſe of *January*, or beginning of *February*, without the leaſt previous notice; except, perhaps, a crudity or apſy for ſome weeks before-hand; with a ſort of intumeſcence, and a heavineſs of the body, which continually increaſes, till at laſt a paroxyſm breaks out; being preceded, ſome days, with a ſort of torpor, and a ſenſible deſcent of the flatulencies through the fleſh of the thighs, with ſome ſpaſmodick ſymptoms. The day before the paroxyſm, the patient's appetite is very greedy; an hour or two after midnight he is waked by a pain, commonly in his great toe, ſometimes in the heel, ancle, or the calf of the leg, not unlike the pain felt upon the diſlocation of the ſaid bones; with a ſenſe as if water was ſprinkled on the part affected. This is ſucceeded by a chilneſs, and ſome approach to a fever: the pain, in the mean time, which at firſt was more remiſs, gradually increaſes; in proportion to which the chilneſs abates. By night it is arrived at its height, and ſettled about the ligaments of the bones of the tarſus and metatarſus; where it ſometimes reſembles a violent tenſion; and ſometimes a laceration of theſe ligaments; ſometimes the biting or gnawing of a dog, or a ſqueezing or coarctation. Thus far the part affected has ſuch an exquiſite ſenſe, that it cannot bear the weight of the linen, nor even the ſhaking of the room, occaſioned by a perſon's ſtepping. Hence a thouſand vain endeavours to get eaſe, by changing the poſture of the body, the poſition of the foot, *&c.* till about two or three o'clock in the morning (the ſpace of a nychthemeron from its acceſs) when a remiſſion is firſt perceived; the morbid matter being by this time tolerably digeſted, or even diſſipated: the patient thereupon drops aſleep, and at his waking finds his pain much abated, but the part newly ſwelled. A few days hence the other foot undergoes the ſame fate: ſometimes both are attacked from the firſt. From the time it has ſeized on both legs, the ſymptoms become more irregular and precarious, both as to the time of invaſion, and the duration thereof. But thus ſtill holds, that the pain recruits in the night, and remits again in the morning. A ſeries of theſe little, alternate acceſſes, *&c.* conſtitute a fit, or paroxyſm of the gout, which holds longer or leſs, according to the age, *&c.* of the patient. In ſtrong people, and thoſe who have had it often, fourteen days is a moderate paroxyſm. In old people, and thoſe long uſed to it, it will hold two months.

For the firſt fourteen days, the patient is uſually coſtive; a loſs of appetite, chilneſs towards evening, and a heavineſs and uneaſineſs of the parts not affected, attend the whole paroxyſm. As it goes off, he is ſeized with an intolerable itching, eſpecially between the fingers; the furfur falls, and his toes ſcale, as if he had drank poiſon.

Such is the courſe of a regular gout; but when thro' improper treatment, it is diſturbed or prolonged, it ſeizes the hands, wriſts, elbows, knees, and other parts: ſometimes diſtorting the fingers, and taking away their uſe; ſometimes generating tophaceous concretions, or knots about the ligaments of the joints, reſembling chalk, or crab's eyes; ſometimes riſing a whitiſh inflammable tumour, almoſt as big as an egg about the elbows.

It may be added, that where a perſon has labour'd under the gout for many years; the pain is ſenſibly leſſen'd each paroxyſm, till at length it becomes rather an uneaſineſs than a pain: hence that reflection of *Sydenham*, *dolor in hoc morbo amariſſimum eſt naturæ pharmacum.*

Prognoſtick of the gout.—The gout is ranked among the number of incurable diſeaſes: in effect, we have no true and aſſured remedy yet diſcovered for it; thoſe that now obtain are little more than palliatives, they tend to aſſuage the pain, to diminiſh it for a time, but not to extirpate it.

Cure of the gout.—Bleeding and purging are found abſolutely prejudicial: emeticks, according to *Pitcairn* and *Etmuller*, may do good in the beginning of the diſeaſe. But upon the whole, nothing in *Sydenham*'s opinion, proves of more ſervice than digeſtives or medicines which ſtrengthen the ſtomach, and promote digeſtion: as angelica-root, enul. campan. the theriac. andromach. the jeſuit's bark, and antiſcorbuticks: theſe chiefly to be adminiſtered in the intervals between the paroxiſms. *Muſgrave* however recommends internally repellents, and principally cardiacks, externally emplaiſters gum. carm. or oxycroc. or cephalic, with burgundy pitch; or green ſear-cloth, commonly called *hat-caſe*, &c. Yet *Delæus* affirms, that repellents do more harm than good;

and

and gives us the following *recipe*, as more than equal to all others. ℞ *Confect. hamech* ʒj. *pulv. jalap* ℈ ſs. *extract. trifol. febrin.* ʒij. *litharg. aur.* ℈ vj. *ſapæ antim.* ʒ ſs. *ſacchar. Canth.* ʒ vj. *ol. elicar, q. ſ. ceræ & picis parum f. ſ. a.* An emplaiſter to be laid on the joint affected, till the pain and the morbid matter be driven away.

The RHEUMATISM (which bears a great reſemblance of the *gout*, whence ſome call it *univerſal gout*) is a painful diſorder felt in various external parts of the body, accompanied with heavineſs, difficulty of motion, and frequently a wandering fever, ſometimes fixed in the muſcular and membranous parts of the body, happening chiefly in autumn, and its proper ſeat is ſuppoſed to be in the *membrana communis* of the muſcles; which it renders rigid and unfit for motion, without great pain.

The *rheumatiſm* is either *univerſal* or *particular*.

Univerſal rheumatiſm is that, which attacks all the parts of the body, even the internal ones.

Particular rheumatiſm is that, which is confined to particular parts. In which caſe the pains are uſually erratick, paſſing from one ſide to another; but ſometimes fixed. This is alſo called a *windy* or *ſcorbutick* rheumatiſm.

The difference between the rheumatiſm and the gout conſiſts chiefly in this, that the rheumatiſm attacks not only the joints, as the gout does, but alſo the muſcles and membranes between the joints.

Cauſe of the rheumatiſm.—The rheumatiſm is ſuppoſed to ariſe from a ſharp ſerous humour thrown on the ſenſible parts, and occaſioning a pain by its vellication.

The expoſing the body too ſuddenly to the cold air, after having heated it to a great degree, is the moſt uſual remote cauſe.

Symptoms.—A fit of the rheumatiſm is frequently preceded by a fever of two or three days, and ſometimes by a ſhivering. The attack happens in various parts of the body, as the hands, arms, thighs, legs, feet, *&c.* a redneſs, ſwelling, and lameneſs often ſucceeding. The pain ſometimes fixing in the loins, and reaching as far as the os ſacrum; this diſorder is called *lumbago*, and bears a near reſemblance to the nephritis; being only diſtinguiſhable therefrom by this, that the latter is attended with a vomiting, which the former is not.

Prognoſtick.—The rheumatiſm uſually proves a tedious laſting diſeaſe, holding for ſeveral months, ſometimes years; not continually, but by paroxiſms, in aged perſons, and thoſe of weak conſtitutions and decayed viſcera; it ſometimes ſeizes the head.

Cure.—The cure is by evacuation, chiefly, according to *Sydenham*, by repeated phlebotomy, with a plentiful uſe of volatiles and diluters. *Sebnitzius* recommends ſudorificks; and *Muſgrave* catharticks and emeticks; and I recommend the hot half-bath with diaphoreticks and diureticks.

RICKETS is a diſorder affecting the bones of children, and cauſing a conſiderable protuberance, incurvation or diſtortion thereof.

Cauſes.—This diſeaſe ſometimes ariſes from a fault in ſwathing the child, rolling him too tight in ſome places, and too looſe in others; placing him in an inconvenient, or too often in the ſame poſture, or ſuffering him to be long wet. It is likewiſe attributed to the want of proper motion, and the uſing of the child to be borne in one arm only; whence the legs and knees remain too long in the ſame incurvated ſituation. Or it may be occaſioned by ſome fault in the digeſtion, occaſioning the aliment to be unequally applied to the body, by which ſome parts of the bones increaſe in bulk more than the reſt.

Prognoſtick.—The rickets uſually appear between the firſt eight months, and the ſixth year of the child's age; the part it affects grows lax, flaccid, and weak; and if it be the legs, they become unable to ſupport the body. All the parts ſubſervient to voluntary motion are likewiſe debilitated and enfeebled; and the child grows pale, ſickly, ſlothful, and cannot ſit erect.

His head generally becomes too large for the trunk, and cannot be ſupported or managed by the muſcles of the neck, which gradually wear away. Swelling and knotty excreſcencies appear in the wriſts, ancles, and tops of the ribs; and the bones of the legs and thighs grow bowed and crooked. The like diſorder ſometimes alſo ſeizes the bones of the arms.

Prognoſtick.—If the ſymptoms continue long, the thorax becomes ſtrait, a difficulty of reſpiration enſues, as alſo a cough, and a hectick fever; the abdomen ſwells, the pulſe grows weak and languid, and the ſymptoms increaſing at length prove mortal.

Cure.—When the diſorder is taken early, it may be remedied by proper boliters and bandages, ſuited to the parts affected; not otherwiſe.

Others chuſe a liniment of rum and palm oil; and others a plaiſter de minio and oxycrocum, applied along the back to cover the whole ſpine. Dry frictions over the whole body, with a warm linnen cloth before the fire, eſpecially on the parts affected, are of great ſervice. The oil of ſnails is

very famous for the ſame intention, being what drops from them, after bruiſing and ſuſpending them in a flannel bag. With this the limbs and ſpinal bone are anointed.

Some want much cold bathing, before the diſtemper comes to be confirmed, during *May* and *June*, continuing the child in the water two or three ſeconds at each plunge; but I do not at all approve of this remedy, for of ſeveral children that have been thus plunged, to my certain knowledge, none have been cured, and ſome have died.

CUTANEOUS DISEASES. The LEPROSY, is a foul cutaneous diſeaſe, appearing in dry, white, thin, ſcurfy ſcabs, either over the whole body, or only ſome part of it; and uſually attended with a vehement itching, and other pains.

Cauſes.—The *leproſy* ſeems to ariſe from a great obſtruction of perſpiration; whereby the thin ſaline humours are thrown off from the blood, and arreſted by the denſity and cloſeneſs of the cuticula.

Symptoms.—The ſymptoms of the antient *lepra*, as laid down by *Galen*, and others, are as follows:—The patient's voice is hoarſe, and comes rather through the noſe than the mouth; the blood full of little white ſhining bodies, like grains of millet, which upon filtration ſeparate themſelves from it; the ſerum is ſcabious, and deſtitute of its natural humidity, inſomuch that ſalt applied to it does not diſſolve; it is ſo dry, that vinegar poured on it boils; and is ſo ſtrongly bound together by little imperceptible threads, that calcined lead thrown into it ſwims. The face reſembles a coal half extinct, unctuous, ſhining, and bloated, with frequent hard knots, green at bottom, and white at top. The hair is ſhort, ſtiff, and brinded, and not to be torn off without bringing away ſome of the rotten fleſh to which it adheres; if it grows again, either on the head or chin, it is always white. Athwart the forehead run large wrinkles or furrows, from one temple to the other; the eyes red and inflamed, and ſhine like thoſe of a cat; the ears ſwell'd and red, eaten with ulcers towards the bottom, and encompaſſed with little glands; the noſe ſunk, becauſe of the rotting of the cartilage; the tongue dry and black, ſwell'd, ulcerated, divided with furrows, and ſpotted with grains of white; the ſkin covered with ulcers, that die and revive on each other, or with white ſpots or ſcales like a fiſh; it is rough and inſenſible, and when cut, inſtead of blood, yields a ſanious liquor. It arrives in time to ſuch a degree of inſenſibility, that the wriſt, feet, or even the large tendon, may be pierced with a needle, without the patient's feeling any pain. At laſt the noſe, fingers, toes, and even privy members fall off entire, and by a death peculiar to each of them, anticipate that of the patient. It is added, that the body is ſo hot, that a freſh apple held in the hand above an hour, will be dried and wrinkled, as if expoſed to the ſun for a week.

Cure.—As to the cure, that which proved effectual in ſouthern countries fails among us, where the ſtrongeſt medicament, and the moſt powerful mercurials are neceſſary. Bathing is judged to be of good uſe in the lepra.

The ITCH is a diſeaſe of the ſkin, wherein it is corrupted by the oozing out of certain ſharp ſaline humours, which gather into puſtules, and occaſion a puritus or itching.

There are two kinds of *itch*, a *humid*, and a *dry* kind. The latter has been uſually ſuppoſed to be owing to an atrabilary humour; and the former to a ſaline pituita.—They are both contagious.

Cauſes.—Dr. *Bononio* has given a much more rational account of the cauſe of this diſtemper, than any author before him: he examined ſeveral globules of the matter picked out of the puſtules of itchy perſons with a microſcope, and found them to be minute living creatures, in ſhape reſembling a tortoiſe, of briſk motion, with ſix feet, a ſharp head, and two little horns at the end of the ſnout. Hence he makes no ſcruple to attribute this diſeaſe to the continual bitings of theſe animalcules in the ſkin; by means of which, ſome portion of the ſerum oozing out through the ſmall apertures of the cutis, little watery bladders are made, within which the inſects continuing to gnaw, the infected are forced to ſcratch, and by ſcratching increaſe the miſchief; breaking not only the little puſtules, but the ſkin too, and ſome little blood veſſels, and ſo make ſcabs, cruſty ſores, *&c.*

Hence we perceive how the itch comes to be catching; ſince theſe creatures, by ſimple contacts, eaſily paſs from one body to another; their motion being wonderfully ſwift, and they crawling on the ſurface of the body, as well as under the cuticula.

Cure.—The cure of the itch is attempted with lixivial waſhes, baths, and ointments made of ſalts, ſulphurs, mercury, *&c.* theſe being very powerful in killing the vermin lodged in the cavities of the ſkin, which ſcratching will never do, they being too minute to be caught under the nails. And if in practice it is found, that this diſeaſe, after it ſeemed to be cured by unction, frequently returns again, this is eaſily accounted for, ſince though the ointment may have killed all the living creatures, yet it may not poſſibly have deſtroy'd all their eggs, laid, as it were, in the neſts of the ſkin; from

from which they afterwards breed again, and renew the diſtemper.

HERPES is a cutaneous heat or inflammation, attended with a roughneſs of the ſkin, and the eruption of a number of little puſtules ſpreading every way.

There are divers kinds of this diſeaſe; as,

Miliary herpes, which is an aſſemblage of innumerable little puſtules, under the cuticle, of the ſize of millet ſeeds; popularly called the *ſhingles*.

The *herpes miliaris*, according to *Wiſeman*, approaches very nearly to the nature of the plora, and therefore to be cured with mercurial cathartick, *&c.*

Simple herpes, is a ſingle puſtule or two, riſing chiefly on the face, of a whitiſh or yellowiſh colour, pointed, and with an inflamed baſe.—Theſe dry away of their own accord, upon letting out the little drops of pus contained in them.

A third ſpecies of herpes is what the *French* otherwiſe call *ſerpigo*; and in *Engliſh*, a *tetter*, or *ringworm*.

Herpes exudens is a more corroſive kind; the puſtules are ruddy, and attended with an itchin g and ulcerate the parts they riſe on.

ERYSIPELAS is a diſeaſe of the ſkin, called St. *Anthony's fire*, whoſe ſeat is any part of the body, but principally the face.

Cauſes of the eryſipelas.—Dr. *Quincy* accounts for the *eryſipelas* from a too fizy blood, which obſtructing the capillaries, occaſions inflammations: others from a too ſharp and bilious blood, which, on account of its great ſubtilty, occaſions no ſenſible tumour; but ſpreads and diffuſes itſelf all around. Its colour, though red, generally inclines towards a yellow, on account of the mixture of bile; and always the more of the bile, the more dangerous the diſeaſe.

There is another ſpecies of *eryſipelas*, though leſs uſual than the former; moſt commonly ariſing from a too copious drinking of ſpirituous liquors.

Symptoms. — The ſymptoms of the firſt kind of eryſipelas, are, that it ſhews itſelf in a ruddy inflammation of the part, with a little ſwelling of the ſame; an intenſe pain, and a crowd of little puſtules, which, as the inflammation increaſes, grow into veſiculæ. The diſeaſe ſpreads itſelf apace; ſhifting from one place to another, with a fever attending it. It attacks the patient all at once, and chiefly when out in the air; whence the country people call it blaſting, *ſideratio*. — The other ſpecies of eryſipelas, begins with a fever, after which there is an univerſal eruption of puſtules, almoſt over the whole body, much like thoſe after the ſtinging of nettles, and ſometimes riſing into veſiculæ. At going off they leave an intolerable itching, and as often as ſcratched, return again.

Etmuller gives it as the diſtinguiſhing character of an eryſipelas, that when preſſed very lightly by the finger, there follows a white ſpot, which preſently after becomes red again; which does not happen in an ordinary inflammation, unleſs when violently preſſed. — Scorbutick people are moſt ſubject to this diſeaſe.

Cure. — It is diſputed, whether purging be good in the eryſipelas? *Sydenham* recommends it the next day after bleeding. *Etmuller* cautions us againſt them both, and recommends diaphoreticks. Dr. *Freind* obſerves, that in the laſt ſtage of an eryſipela's of the head, attended with a coma, delirium, *&c.* unleſs cathartick will do good, the caſe is deſperate. All unctuous aſtringents, and cold applications, externally, are dangerous; and ſometimes makes the eryſipelas degenerate into a gangrene.

DISEASES *of the* EYES. OPHTHALMIA is a diſeaſe of the eyes, properly, an inflammation of the *tunica adnata*, or *conjunctiva*, accompanied with a redneſs, heat, and pain.

The *ophthalmia* is either moiſt or dry: in the firſt there is a ſhedding of tears, in the ſecond none at all.

Cauſes of the Ophthalmia. — The immediate cauſe of the *ophthalmia*, is the blood flowing in too great abundance in the little veſſels of the *adnata*, ſo as to ſtagnate therein, and diſtend them. The remote cauſes are the ſame with thoſe of other inflammations. In ſummer it is frequent to have *epidemick ophthalmia's*.

Symptoms. It ſometimes happens in the *ophthalmia*, that the two eye-lids are ſo diſtorted, that the eye continues conſtantly open, without being able to ſhut; which is called χημωσις; ſometimes the eye-lids are ſo faſten'd together, that the eye cannot be open'd, which is called φιμωσις, *q. d.* cloſure of things that ſhould be open.

Cure. — Snow applied to the afflicted eye, is reputed a good remedy for the *ophthalmia*: the *Ephemerides* of the *Leopoldine* academy, mention an *ophthalmia* cured by applying cow's dung, while hot, between two linen cloths, to the eye. A fox's tongue, and the fat and gall of a viper, are empirical preſervatives againſt the *ophthalmia*. — The cure of the *ophthalmia's*, according to the modern practice, depends chiefly on the due repetition of purgatives. If theſe fail, recourſe is had to veſicatories, iſſues, ſetons, *&c.* *Thomas Pitcairn* prefers bleeding; it being his obſervation, that no

disease requires copious bleeding so much as the *ophthalmia*.

Pitcairn, and some others, distinguish an external and internal *ophthalmia*; the first in the *adnata*, which is that hitherto spoke of; the second in the *retina*. The symptoms or indications of the latter, are *muscæ volitantes*, dust seeming to fly in the air, &c. This when inveterate, degenerates into a *gutta serena*, or *amaurosis*.

Gutta Serena is a disease of the eyes, being an entire privation of sight, without any apparent fault or disorder of the part, excepting that the pupil looks somewhat larger, and blacker than before.

Cause of the gutta serena.——Its cause is supposed to be a compression, or obstruction of the optick nerves, which prevents the due flux of the animal spirits into the *retina*.

Symptoms.—The *muscæ volitantes* are a pathognomonick sign of a growing *gutta serena*.

Prognostick.—The *gutta serena* is one of the most dangerous and untractable of all the diseases of the eyes.

Cure.—The cure of the *gutta serena*, according to *Pitcairn*, must be attempted with mercurials, and even salivation, and with decoctions of guaiacum.

Before we proceed to the last part of *medicine*, I shall insert a few remarks on the several sects which have arose in this science.

Empiricks. *Empirici*, were such physicians of antiquity as formed themselves rules and methods, on their own practice and experience, and not on any knowledge of natural causes, or the study of good authors, and who prescribed without enquiring into the nature of the disease, or the properties and virtues of their medicines; depending wholly on the authority of some general experienced remedies.

Medicine was almost altogether in the hands of *Empirics*, till the time of *Hippocrates*, who first introduced reason, and the use of theory therein; and hence arose a new sect called *Theoretici*.

The word *Empirick* is now confounded with that of *Charlatan*, or *Quack*, and applied to persons who practise physick at random, without a proper education, or understanding any thing of the principles of the art; retailing their poisonous *nostrums*, in some publick place, where, by their buffooneries, they assemble the ignorant rabble, on purpose to cozen them of their pence, and but too often of their health.

Dogmatists. The *Dogmatists*, were a sect of antient physicians called also *Logici*, Logicians, from their using the rules of logick and reason in subjects of their profession.

They laid down definitions and divisions, reducing diseases to certain genera, those genera to species, and furnishing remedies for them all; supposing principles, drawing consequences, and applying those principles and consequences to the particular diseases under consideration. In which sense the *Dogmatists* stand contradistinguished to *Empiricks* and *Methodists*.

The *Dogmatists* were those, who brought physick into a form and arrangement like those of other speculative sciences, defining, dividing, laying down the principles and drawing conclusions: and hence also the apellation of *Logici*, q. d. reasoners. They also applied themselves to seek the causes of diseases, the nature of remedies, &c.

Erasistratus, a famous *Dogmatist*, went so far, that not contented to dissect dogs, and other brute animals, he begged condemned criminals of the magistrates, opened them while alive, and searched in their entrails.

Methodists. The *Methodists* were a sect of antient physicians who reduced the whole healing art, to a few common principles, or appearances.

The *Methodists* were the followers of *Thessalus*, whence they were also called *Thessalici*. They were strenuously opposed by *Galen* in several of his writings; who scrupled not to assert, that the methodical heresy ruined every thing that was good in the art.

Quincy mistakenly uses *Methodists*, *Methodici*, for those physicians, who adhere to the doctrine of *Galen* and the schools; and who cure with bleeding, purges, &c. duly applied according to the symptoms, circumstances, &c. in opposition to Empiricks and Chymists, who use violent medicines and pretended secrets, or nostrums.

Galenists. The *Galenists*, are such physicians as practise, prescribe, or write on *galenical* principles, thus called because introduced by *Claudius Galen*, born at *Pergamus* in *Asia*, the son of *Nicon*, a famous architect, and pupil of *Satyron* and *Perops* two able physicians. He first distinguished himself at *Athens*, then at *Alexandria*, and lastly at *Rome*; where he wrote a great deal, and where he also died in the year of Christ 140.

He is said to have composed two hundred Treatises, whereof there are one hundred and seventy still extant.

This author digesting and collecting what the authors before him had done; and explaining every

every thing according to the ſtricteſt doctrines of the *Peripateticks*, ſet *phyſick* on a new footing, introduced the doctrine of the four elements; the cardinal qualities, and their degrees, and the four humours or temperaments.

Medicine was wholly *galenical*, till the times of *Paracelſus*. *Geber* indeed, and after him *Raymond Lully*, *Arnoldus de Villa Nova*, and *Baſil Valentine*, made ſome attempts to apply *chymiſtry* to *medicine*, eſpecially the laſt of them; but no great advance was made. *Paracelſus*, and after him *Van Helmont*, altered the whole body of *medicine*, exploded *galeniſm*, and the *peripatetick* doctrine, and rendered *medicine* wholly *chymical*.

The late improvements in philoſophy, have reformed and retrieved the *galenical medicine*, which has now little of *Galen*'s in it. It is become all *mechanical* and *corpuſcular*: inſtead of qualities and degrees, every thing is now reduced to *mechanical* affections; to the figures, bulks, gravities, &c. of the component particles, and to the great principle of attraction.

The *Galeniſts* ſtand oppoſed to the *Chymiſts*: the *materia medica* of the firſt is chiefly of the vegetable kind; the virtues of which they procure by the more ſimple and eaſy means, and ſeldom go beyond decoction. The latter take in minerals, ſalts, ſtones, and even metals, and ſemi-metals: theſe, they hold, afford more efficacious remedies, and their virtues, procured by long, artful, laboured proceſſes, with the help of fire, are had more pure, and in a leſſer compaſs.

At preſent the *Galeniſts* and *Chymiſts* are pretty well accommodated, and moſt phyſicians uſe the preparations and remedies of both, as appears in the following preſcriptions.

We are now arrived at the laſt branch in our diviſion of medicine, which furniſhes the *materia medica*, &c.

Here we are firſt to conſider the buſineſs of an Apothecary.

APOTHECARY, from ἀποθήκη, *ſhop*, is a perſon whoſe profeſſion is to execute the phyſician's preſcriptions, in the preparation and compoſition of medicines or remedies, which are to be adminiſtred to the patient.

His knowledge muſt be particularly improved in *pharmacy*, i. e. *remedy*, which is an art or ſcience which teaches how to chuſe, prepare and mix remedies.

Pharmacy is divided into *galenical* and *chymical*.

Galenical PHARMACY conſiſts in the knowledge and management of the ſeveral parts of the *materia medica*, now in the hands of the Apothecaries.

Chymical PHARMACY, called alſo *ſpagyrical* and *hermetical*, is that introduced by *Paracelſus*, who calls it *ars diſtillatoria*, conſiſting in the reſolving of mixt bodies, in order to ſeparate from them the uſeleſs ſubſtances, and make of them more exalted and eſſential remedies.

Pharmacy has for its object all the natural bodies, called mixts; which are divided into three claſſes, *viz. animals*, *minerals*, and *vegetables*.

Under *animals* is included not only their fleſh, but likewiſe their bones, nails, milk, blood, hairs, and excrements.

Under *minerals*, the ſeven metals, mineral matters, ſtones, and earths.

And under *vegetables*, the plants, ſaps, gums, reſines, fruits, excreſcences, ſeeds, flowers, moſſes, rinds, roots, juices, tartars, fæculæ, and all other things which proceed from them.

Of all thoſe things here recapitulated, *pharmacy* has found the ſecret to prepare remedies for the cure of the different maladies, the human body is afflicted with. But what can be meant by that term *remedy*?

A REMEDY is all that being applied outwardly, or given inwardly, excites ſome alteration in our humours, and cauſes in them a ſalutary change-ment.

Remedies are divided into *ſimple* and *compound*.

Simple remedies are thoſe employ'd as they grow naturally; ſuch are all thoſe which *Botany* ſupplies us with.

Compound remedies are a mixture of ſeveral ingredients.

Remedies are moſt commonly divided, on account of their virtues, into *alterative*, *purgative*, and *ſtrengthening*.

Alterative remedies are thoſe, which being applied outwardly or given inwardly, procure ſome change in our body, either by heating or cooling, humecting or drying, ſoftening or condenſing, rarifying or ſoporiferous, binding or opening, digeſting or reſolving, corroding or inſpiſſating, deterging or ſtopping.

Purgative remedies are thoſe, which by a certain fermentation and irritation they excite in the body, looſen the ſuperfluous humours, liquify them, and put them in a condition of being evacuated. Which remedies I divide into *cathartick* or *purgative*, *emetick* or *vomitive*, *diaphoretick* or *ſudorifick*, *diuretick* or *aperitive*.

The *cathartick* or *purgatives*, are ſubdivided into *phlegmagogues*, *cholagogues*, *melanagogues*, *hydragogues*, and *panchymagogues*.

The *phlegmagogues* are thoſe, which being compoſed of volatile and penetrating parts, are more

more diſpoſed than others to be uſhered to the brain where they rarefy and diſſolve the *pituita*, whence they are ſaid to purge particularly the brain; ſuch are the *agarick*, *coloquintida*, the ſeed of cardamum, and the flowers of peach trees.

The *chalagogues* are thoſe, which having not ſo much action as the others, are only capable to ſtir the humours which are ſoon looſen'd, whence they purge the bile ſooner than any other humour; ſuch are the *caſſia*, *rhubarb*, *manna*, and *honey*.

The *melanagogues* are thoſe, which being compoſed of fix'd and extremely purgative parts, diſſolve the tartarous and melancholick humour, which is the moſt difficult to unlooſen: ſuch are the *ſcammony*, *turbith*, *ſenna*, *hellebore*.

The *hydragogues* are thoſe, which being compoſed of reſinous and ſaline parts, open the lymphatick veſſels, and make the ſeroſity to flow: ſuch are the *jalap*, *mechoacan*, *iris*, &c.

The *panchymagogues* are mixtures of all kinds of purgatives; and are ſaid to purge all humours: ſuch are the *catholicon*, the *confection hamech*, the *extract panchymagogues*, &c.

Emeticks or *vomitives* are purgatives full of ſaline ſulphurs, ſo much diſpoſed to motion, that they act as ſoon as they are in the ſtomach: ſuch are the *liver of antimony*, *emetick tartar*, *vitriol*, *azarum*, *verdigreaſe*, *tincture of tobacco*, *the juice of wormwood*, and of *carduus benedictus*, the *white* and *black hellebore*, &c.

Diapharetick or *ſudorifick remedies* are thoſe, which being compoſed of volatile parts, open the pores of the body, and expel the humours by perſpiration: ſuch are the *volatile ſalts*, the *china-root*, *ſarſaparilla*, *gayac*, &c.

The *diuretick* or *aperitive remedies* are thoſe, which being compoſed of ſaline and penetrating parts, rarefy the blood, and make the ſeroſity thereof to precipitate with more rapidiy than before: ſuch are the *ſalprunellæ*, the *ſpirit of ſalt*, *white wine*, *parſley*, *bruſcus*, *aſparagus*, *parietary*, &c.

Strengthening remedies are thoſe, which by the conformity of their parts, with the ſpirits of our body, rectify the alterations, which had happen'd in the humours, or the ſpirits themſelves, by exciting in them the motion, which had been interrupted, either by moderating that which is too violent, or by expelling the impurities.

Remedies heat or cool, either by themſelves or by accident. They *heat* of themſelves when being compoſed of ſaline and ſulphurous parts, they increaſe the agitation of the humours in the body of thoſe who uſe them: ſuch are *wormwood*, *ginger*, *cinnamon*, *pepper*, *cloves*, *nutmeg*, &c. They heat by accident, when in cauſing obſtructions in ſome veſſels, the humours which were to run through are ſtopped and ferment in them, whence reſults a heat in the whole body: ſuch are the *narcoticks*, *acids*, and ſeveral raw fruits.

They *cool* of themſelves, when being compoſed of aqueous and glutinous parts, they temperate the acrimony of the humours, and moderate the rapidity of their courſe: ſuch are *lettuces*, *porcelain*, *bugloſs*, the *gums tragacanth* and *arabic*, &c. They cool by accident, when being hot and acrimonious, but in a ſmall quantity in a great deal of aqueous liquor, they ſerve as a vehicle to it, to make it penetrate: ſuch are *brandy*, *ſpirit of vitriol*, *ſpirit of ſulphur*, &c. Theſe acid ſpirits cool, likewiſe, in fixing and precipitating the volatile ſalts and ſulphurs of the body, which by their too great agitation cauſed the heat: they cool, beſides, in puſhing by urine, becauſe they carry off, and expel the humours, which by their ſojourning, produce in the veſſels a foreign heat.

Remedies are humecting, when being aqueous or phlegmatick they increaſe the aqueous part of the humours: ſuch as *mallows*, *porcelain*, *lettuce*, and *cucumbers*.

Remedies dry in four different manners. 1. When by the tenuity of their parts, or their ſulphurous ſalts, they uſher out thro' the pores the ſuperfluous humidities: ſuch are the *ſarſaparilla*, the *china-root*, *ſaſſafras*, *gayac*, &c. 2. When by their terreſtrial and porous parts, they abſorb and blunt the acrimonious humours: ſuch are the *litharge*, *terra ſigillata*, *lapis calaminaris*, *crabs eye*, *coral*, and other alkaline matters. 3. When being cauſtick, they burn the extremities of the ſmall veſſels, which ſupply the part with humour, and form there a trombus, which hinders the wound from being drenched with that humour as it was before: ſuch are the *vitriol*, *burnt allum*, *lapis infernalis*, *red precipitate*, and the *corroſive acid ſpirits*. 4. When, being deterſives, they cleanſe the wounds of their *ſania*; for there being then no more matter to excite a fermentation, the fleſh grows, and the cicatrice is formed: ſuch are the *phagedenic water*, *water of arquebuſade*, the *tincture of aloes*, and of *myrrh*, the *ariſtoloches*, and other *vulneraries*.

Remedies mollify or ſoften, when they are compoſed of mucilaginous or ſlimy parts, and of ſome ſalt, which ſerve for a vehicle to make them penetrate: ſuch are *mallows*, *violets*, *line-ſeeds*, and *fenugreec-ſeeds*.

Remedies condenſe in two manners. 1. In drying the ſuperfluous humours: ſuch are the *ſudorificks*. 2. In congealing the humour by the cold they communicate to the part, when they are applied upon it: ſuch are *lead*, the *ſperm of frogs*, the

the *white of eggs*, *cold water*, &c. or in congealing the humour by means of the acid they contain: ſuch are *ſorrel*, *barberries*, *gooſeberries*, *ſtrawberries*, *oxicrat*, and the *acid ſpirits* taken inwardly.

Remedies rarefy or attenuate, when being compoſed of ſubtile and penetrating parts, they divide the humours and render them more fluid: ſuch are the *ſpirit of wine*, and the *volatile ſalts*.

Remedies are ſoporous in two manners. 1. By cooling the blood a little, and moderating its too great rapidity: ſuch are the *emulſions*, *lohochs*, and *fomentations*. 2. In carrying a narcotick or thickening vapour to the brain, which moderate the motion of the ſpirits, and hinders them from circulating with ſo much impetuoſity as they did before: ſuch are *poppies* and *opium*.

Remedies are aſtringent, (1.) By their ſtypticity; becauſe being impregnated with a terreſtrial and crude acid, they coagulate eaſily the humours, by the approximation of the fibres of the *viſcera*: ſuch are the *ſumach*, *quinces*, *medlars*, &c. eſpecially before they are ripe. (2.) By their terreſtrial and alkaline parts, becauſe they abſorb the acrimonious humour, which cauſed the looſeneſs and vomiting: ſuch are *terra ſigillata*, *bol*, *chalk*, &c. (3.) In exciting ſweat, becauſe they uſher out through the pores the cauſe of the malady: ſuch are the *china-root*, *ſarſaparilla*, *diaphoretick antimony*, &c. (4.) In purging, which they do firſt, when thoſe remedies, beſides their purgative quality, contain terrene or ſtyptick parts, which, after the evacuation, remain and produce their effect: ſuch are the *ipecacuanha*, *rhubarb*, *myrabolans*, *tamarines*, &c. And by accident, when after the evacuation the purgative has excited, one is hard bound for ſeveral days afterwards, that effect proceeding from the remedy having evacuated a great deal of humidities, there is not enough left in the inteſtines to humect the matters. (5.) They are aſtringent, when being aperitive, they divert the ſeroſities, which flow into the inteſtines: ſuch are the roots of *gramen*, &c.

Remedies looſen the abdomen or belly, either by exciting in the body ſome ſlight purgative fermentation: ſuch are the *violets*, *prunes*, *apples*, *cherries*, or by ſoftening and liquifying the matters; ſuch are *milk*, *veal-broth*, the decoctions of *borage* and *bugloſs*; and the *fomentations* and *baths*.

Remedies are digeſtive, or excite ſuppuration, by their ſaline and penetrating parts, which rarefying the humours ſtopped, give them motion and fermentation enough to break the ſkin; and force its way through: ſuch are *onions*, *gums*, *levana*, &c.

Remedies are reſolutive. 1. When being full of volatile and penetrating parts, they open the pores and give an iſſue to the humour which cauſed the malady: ſuch are the *volatile ſpirits*, and *mercury*. 2. When being compoſed of mucilaginous and molliſying parts, they mollify the humour which had too much conſiſtence, and diſpoſe it to be uſhered out by the circulation of the blood, and of the other humours: ſuch are *poultices*, and the *plaiſters of mellilot*, and of *mucilage*. 3. When being compoſed of cold and condenſing ſubſtances, they appeaſe the too great motion of the ſpirits, which cauſed the malady; and hinder them from returning in ſo great a quantity: ſuch are *lead*, *marcaſſites*, the *ſolanum*, the *henbane*, the *mendragora*, &c.

Remedies are corroſive when they are impregnated with very acrimonious, pricking, and burning ſalts: ſuch are *lapis infernalis*, *cauſtick ſtones*, *red precipitate*, *corroſive ſublimate*, and *butter of antimony*.

Remedies are inſpiſſating, when being compoſed of glutinous parts, they thicken the humours: ſuch are the roots of *ſymphitum*, of *althæa*, *pearl-barley*, the *gums tragacanth* and *arabick*, and the *ſarcocolla*.

Remedies are deterſive, when being compoſed of ſaline or rarefying parts, they diſpoſe the humour towards looſening itſelf: ſuch are the *aloes*, *myrrh*, *phagedenick-water*, *allum*.

Remedies ſtop or hinder the humours from flowing any more on a part already afflicted, as on a wound: ſuch are the common *oxycrat*, the *oxycrat of ſaturn*, and the *chalybeate-wine*.

Cordial or *cardiack remedies* are thoſe, which ſtrengthen the heart, in repairing the exhauſted ſpirits, and giving the body more vigour than it had before.

There are two ſorts of thoſe *remedies*, viz. rarefying, and fixing.

The fixing by the tenuity of their ſubſtance, and their volatility, increaſe the motion and circulation of the humours: ſuch are the *powder of viper*, the *confection of alkermes*, *muſk*, *ambergreaſe*, *cinnamon*, &c.

The fixing by their acidity, or narcotick quality, moderates or ſuſpends the too impetuous motion of the ſpirits: ſuch are the *ſpirit of vitriol*, the *acid juices of lemons*, *oranges*, *gooſeberries*, *barberries*, and the *narcoticks*.

Cephalick remedies are thoſe, which being compoſed of ſulphurous and ſaline volatile parts, give an agreeable vapour to the brain, which, after it has attenuated and diſſipated in part the coarſer *pituita*, revive the animal ſpirits, and excite the

circulations

circulations of the humours: such are *tobacco*, *betony*, *stœchas*, *sage*, *marjoram*, *cloves*, *thyme*, *rosemary*, *lavender*.

Ophthalmick remedies are those, which strengthen and cure the maladies of the eyes, whereof there are several sorts. — Some of them strengthen in heating, when the sight has been debilitated by want of spirits, or by a fluxion of some pituitous or phlegmatick humour: such are *brandy*, *fennel-water*, *hungary-water*, &c. The others strengthen the eyes in cooling them, when they are red and inflamed: such are *nurse's milk*, *plantain-water*, the *white of eggs*, &c. The others cure the eyes in deterging and drying the little ulcers formed in them: such are the *colyrium of Lanfranc*, *prepared tutty*, *salt of saturn*, *sugar-candy*, *iris of Florence*, *vitriol*, and the *troches of rhasis*.

Dentrifick remedies are those, which being detersive and astringent, are proper to cleanse the teeth, fasten them, and strengthen their ligaments; such are the *chalybeate wine*, the *wood of lentisk*, *red roses*, *coral*, *pumice-stone*, *burnt bread*, *cream of tartar*: some rank among those remedies, the *spirits of vitriol*, and of *salt*, which cleanse and whiten the teeth in a very short time; but corrode and spoil them.

Pectoral remedies are those, which being composed of oily, soft, and temperate substances, soften the acrimonious humours which could fall into the breast, and loosen the phlegm adhering to it: such are *milk*, *honey*, the *tussilago*, the *capillaries*, the *pulmonary*, the *red poppies*, the *borage*, the *bugloss*, the *liquorice*, the *root of althæa*, *raisins*, *almonds*, *figs*, *dates*, *pistachoe-nuts*, and *jujubes*. We use, likewise, detersive and rarefying *remedies* in the maladies of the belly, where there is obstruction; as in the asthma, such are the roots of *enula campana*, of *iris*; the preparations of *sulphur*, and of the *flowers of benjoin*.

Stomachick remedies are those, which being composed of saline, acrimonious, and attenuating parts, excite heat, and fermentation enough in the stomach, to dissolve a viscous and phlegmatick matter, which embarrasses its fibres, obstructs the motion of the spirits, and hinders the digestion: such are *cinnamon*, *nutmeg*, *coriander seed*, *anniseed*, *fennel*, *wormwood*, *mint*, *lemon*, and *orange-peels*. Sometimes also, those fibres of the stomach being only relaxed, there want but astringent remedies to strengthen them: as *conserve of roses*, *confection of alkermes*, &c.

Hepatick remedies thus called because they were supposed to strengthen the liver, are proper to correct the vices of the blood: such are the *chicory*, *lettuces*, *hops*, *agrimony*, *polipody*, *fumitary*, *rhubarb*, *aloes*.

Splenick remedies, thus called because useful in the maladies of the spleen, abound with aperitive salts, which purge by urine, and carry off the obstructions of the spleen, and of the other viscera: such are the *ceterach*, the *tamaris*, the *caper-tree*, the *chervil*, the *great centaury*, and the *mars*.

Hysterick remedies are those, which are employ'd for the maladies of the womb, or *matrice*, whereof there are several sorts. Some of them being composed of subtile or spirituous saline parts, help that part towards the expulsion of what is hurtful to it: such are the *troches of myrrh*, the *oil of succin*, *cinnamon-water*, *castoreum*, *aristoloche*, *artemisia*, *matricaria*, *melissa*, *rue*, *savern*, *white marrubium*, *saffron*, *acorns*, *gum-ammoniac*, *galbanum*, *assa-fœtida*, *sagapenum*, *opoponax*, *camphire*. The others being composed of fixed or condensing parts, appease and abate the vapours which arise from the matrice: such are *common water*, *spirit of vitriol*, *spirit of nitre* dulcified, and the *laudanum*.

Carminative remedies are those, which being composed of spirituous and saline parts, rarefy and dissolve the coarse matter which retained the winds in the body, and procure their expulsion, such are *anniseeds*, *fennel-seeds*, *camomile*, *melilot*, *cinnamon*, *nedmary*, *coriander-seeds*.

There are *herbs*, *roots*, *flowers*, *seeds*, *farinæ*, *waters*, *oils*, *unguentums*, &c. to which are attributed the qualities and virtues above-mentioned in a particular manner, *viz.*

The *vulnerary* Herbs are the *agrimony*, *bugle*, *sanicle*, *alchymilla*, *periwinkle*, *pulmonary*, *veronica*, *brunella*, the *capillaries*, and several others.

The *five aperitive* Roots are those of *bruscus*, *asparagus*, *fennel*, *parsley*, and *smallage*.—Several other roots are also *aperitive*, and as much in use as those, *viz.* those of *gramen*, of *eringium*, of *marsh-mallows*, &c. but it pleased the antients to find thus the number of *five aperitive roots*.

The *five* Capillaries are the *common* or *black adiantum*, the *white adiantum*, called *capillary of Montpelier*, the *polytric*, the *ceterach* or *scolopander*, and the *salvia vitæ*, or *ruta muraria*.

The three *cordial* Flowers are those of *bugloss*, of *borage* and of *violet*. Several other flowers could be as justly called *cordial*, as those of *gelly-flowers*, or *ros solis*, and of *roses*.

The *four carminative* Flowers are those of *camomile*, of *melilot*, of *matricaria*, and of *anthum*.

The common *emollient* Herbs are the *mallow*, *marsh-mallow*, *branc-ursina*, *wall-flowers*, *mercurialis*, *parietary*, *heath*, *atriplex*, the *roots of white lilies*, &c.

The *four large* Cold Seeds are those of *gourd*, *water-melon*, *melon*, and *cucumber*.

The

The *four ſmall* COLD SEEDS are thoſe of *lettuce*, *purſlain*, *endive*, and *ſuccory*.

The *four great* HOT SEEDS are thoſe of *anniſeed*, *fennel*, *cumin*, and *caraway*.

The *four ſmall* HOT SEEDS are thoſe of *ſmallage*, of *ſtone-parſley*, *biſhop's-weed*, and *wild-carrot*.

The *four cordial* WATERS are thoſe of *endive*, of *ſuccory*, of *bugloſs*, and of *ſcabious*; to which might be added ſeveral other waters of equal virtue, as thoſe of *carduus benedictus*, of *ulmaria*, of *ſcorſonnary*, of *oxytriphyllum*, of *ſorrel*, of *meliſſa*, of *black cherries*, and of *borage*.

The *four antipleuritick* WATERS are thoſe of *ſcabious*, of *carduus benedictus*, of *taraxacon*, and of *red poppies*.

The *three ſtomachic* OILS are thoſe of *wormwood*, of *coinces* and of *maſtich*. There are others, which have ſtill more virtue, as thoſe of *nutmeg*, of *mace*, of *cloves*, and of *bays*.

The *three hot* UNGUENTS are the *ungent of Agrippa*, the *unguent of althæa*, and the *unguent nerval*.

The *four cold* UNGUENTS are the *album rhaſis*, the *populeum*, the *cérat of Galen*, and the *unguent of roſes*.

The *four* FARINÆ, or *flours*, are thoſe of *barley*, of *beans*, of *broom-rape*, and of *lupines*: to which are often added thoſe of *wheat*, of *lentils*, of *line* and *fenugreek-ſeeds*.

Having thus given a general idea of the qualities and virtues of the different remedies, and of their different manner of operating, I'll proceed to the preparation of thoſe remedies, according to the rules preſcribed by the *Galenical pharmacy*.

The *Galenical* PHARMACY is reduced to three general operations, which are the *election*, *preparation*, and *mixture of the remedies*.

The ELECTION conſiſts in the choice of the ſimple drugs, the remedies are compoſed of. To proceed with exactneſs in that choice, ſeveral circumſtances are to be obſerved, *viz.* the *places* where thoſe drugs grow, the *climate*, the *neighbourhood*, the *time*, the *ſubſtance*, *ſmell*, *taſte*, *colour*, *bigneſs*.

1. As to the *places*; ſome drugs require the air of the woods, or fields; others the culture of gardens; ſome aquatick or marſhy, others dry and parched up places; ſome mountains and hills, and others vallies; ſome walls and rocks, others the ſides of roads, ditches or vineyards; ſome fat, and others ſandy earths.

2. As to the *climate*; ſome excel in hot, and others in cold countries; thus the *ſenna* of the *Levant* is much more purgative than that, which grows in other countries: the *iris* and *fennel* of *Florence* is much better than thoſe of *England* and *France*. The *cochlearia* is more abundant, and has more virtue in *England* and *Holland* than in *France*.

3. As to the *neighbourhood*; ſome acquire more virtue from the neighbouring plants, as the *epithym* from the *thyme*, the *caſcata* from the *line*, the *polypodium* and *miſſeltoe* from the oak. Others have more ſtrength when they are at a diſtance from one another, as the *coloquintida*.

4. As to the *time*; ſome are in their greateſt vigour in the ſpring, others in the ſummer, and others in autumn; though no very preciſe time can be fixed in that occaſion; for according to the difference of the climates, the mixt grow ſlower or quicker. The general rule is, that plants are to be gathered, if poſſible, in fair weather, before they ſhoot forth their ſeeds:—The *fruits*, *ſeeds*, *fungus*, muſt be gathered when they are at their full growth. The animals muſt be killed young, vigorous, and before they have copulated with the female. And the *minerals* muſt be dug out of the mines when they have the bigneſs, ſolidity, weight and colour required.

5. As to the *ſubſtance*; the one muſt be compact, as the *opium*; the other friable, as *ſcammony*; the others heavy, as *caſſia ligna*; others light, as *agarick*. Some liquids as common *terebinthine*; others hard and dry, as *aloes*; others ſoft as the *tamarinds*, and others hard, as the *myrabolans*.

6. As to the *ſmell*; ſeveral remedies are much better, as they are more odorant, as the *ſanders*, *ſaſſafras*, and *cinnamon*.

7. As to the *taſte*; ſome are ſweet, as the *liquorice*; bitter, as the *aloes*; ſour, as the *tamarinds*; hot, as the *ginger*; ſtyptick, as the *acatia*.

8. As to the *colour*; ſome muſt be white, as the *agarick*; black, as the *tamarinds*; red, as *ſanguis draconis*; green, as the *verdet*; blue, as the *curcuma*; grey, as the *jalap*.

9. As to the *length* and *bigneſs*; ſome muſt be long, and moderately big, as, the *caſſia*, the *vipers*, &c. others muſt be ſmall, as *hartshorn*, which muſt be taken while young, and puppies.

The PREPARATION of *remedies*, conſiſt in *waſhing*, *picking*, *drying*, *humecting*, *infuſing*, *maturating*, or *boiling* them.

1. They muſt be waſhed either to cleanſe them of the dirt, as it is done to roots as ſoon as they are taken out of the ground, or to purify them of ſome acrimonious part they contain; thus the *litharge* and *tutia* are waſhed in water; or to increaſe their virtue, as when *pomatum* is waſhed in odorous water.

2. They muſt be picked of their coarſe and uſeleſs parts, as *ſenna* is picked of its ſticks and dead leaves; a ſort of ſtring is picked off certain roots; the ſtones are picked out of dried raiſins, thoſe ſtones being hard and aſtringent.

3. They muſt be dried, as the vegetables and animals which are expoſed to the ſun, or dried from it, that the humidity thereof being diſſipated, they may be kept without corruption. But as the flowers in drying often loſe their colour and ſmell, ſome of them muſt be wrapped up in grey paper, in ſmall bundles, as thoſe of *St John's-wort*, and of *little centaury*. For *red roſes* they muſt be dried quickly in the ſun, for if they were dried ſlowly they would loſe their colour; the large roots can ſcarcely be dried without the inſide rotting, and we often ſee large pieces of rhubarb ſpoiled in the heart, therefore they muſt be choſen of a moderate bigneſs. The roots of *jalap*, of *mechoacam*, and of *briony* are cut in ſlices, that they may be eaſier dried. The *fruits* which abound in ſuperfluous humidity, muſt be dried in an oven, otherwiſe they rot: *vipers* muſt be faſtened to a ſtring and dried from the ſun.

Thoſe drugs ſhould not be dried too long, leſt they ſhould loſe the beſt of their ſubſtance. When dried they muſt be kept in boxes.

4. They muſt be humected; thus *ſteel filings* and *iron-ruſt* muſt be humected with dew or rain-water, to open them and increaſe their virtue.

5. They are infuſed in liquors, either to diſſolve them, as *ceruſs* in vinegar, or to communicate their virtue to the liquor, as when *rhubarb*, *ſenna*, or *red roſes*, are ſteeped in water; or to correct the too great ſtrength of their action, as when the root of *eſula* is ſteeped in vinegar before it is uſed; or to open them and increaſe their virtue, as when *dates* are ſteeped in white wine, or hydromel, and when antimony is ſteeped in an acid liquor to render it emetick; or to preſerve them as when fruits, roots, or animals are preſerved in brandy or vinegar, or to render them britly, ſo that they may be eaſily pulverized, as when red-hot cryſtal and flints are extinguiſhed in water.

6. They are *macerated* or *put in digeſtion*, as when after red roſes have been pounded, they are put in a pot, covered with ſalt, and left thus for ſeveral months, that the ſalt and oil being exalted by fermentation, a greater abundance of ſpirits may be extracted from them when they are diſtilled. Honey is made to ſcum in water, then is put in a warm place for ſeveral months, that by digeſtion and fermentation it may grow vinous.

7. They are boiled either to ſoften them, as when the roots of *enula* and *althæa* are boiled to extract a pulp from them, or that they may communicate their quality to the decoction, as when *ptiſans* are made; or to render them thick, as when the *juice of quinces* is boiled in *ſapa*; or to preſerve them, or to correct them, as when the *caſſia* is boiled to hinder it from exciting vapours; or to free them of their uſeleſs parts, as when the *litharge* and other preparations of lead are boiled with oil or greaſe; or to increaſe their ſtrength, as when *rhubarb* is torrified to render it more aſtringent; the *alum* calcined to render it eſcarotic.

8. They are ſawed or cut, as the *woods*; hatched, as the *herbs*; raſped, as *hart-horn*; filed, as *iron* and *ſteel*; broken or bruiſed, as *roots* and *dried fruits*.

9. They are reduced into powder, either in a mill, as the *farinæ*; or in a mortar, as the *ſenna*, *rhubarb*; or on a porphyry with a muller, as the *coral*, and *pearls*.

1. The *mixture of remedies* conſiſts in mixing and uniting them together, in order to form compoſitions of them. For that *mixture* we muſt firſt diſtinguiſh the ingredients, which unite naturally together, from thoſe, which cannot be united but by art: oil, for example, unites very well with fat ſubſtances, but it cannot mix but imperfectly with watery ones; therefore the mixture thereof muſt be made in a mortar, as in the preparation of the *unguentum nutritum*, or *butter of ſaturn*: ſpirit of ſalt ſeems to mix eaſily with the ſpirit of wine, which notwithſtanding, the mixture is more intimate when they are made to circulate together in a circulatory veſſel, as in the preparation of *ſpirit of ſalt dulcified*. Some *oil of cinnamon*, or other *eſſence*, is mixed with ſugar-candy in powder to make the *oleum ſaccharum*, that the oil being thereby rarefied in the parts of the ſugar, may be diſſolved with it in watery liquors: *turpentine* is mixed with yolk of eggs to render it diſſoluble in decoctions.

2. One muſt know the means to be uſed for the mixture of drugs; for it ſuffices ſometimes to agitate them together in a mortar, as *powders*; and when *mercury* is to be extinguiſhed in turpentine: ſometimes they muſt be beaten a long time, as when *flowers* are mixed with ſugar for *conſerves*, when maſſes for pills, and troches are to be made; ſometimes they muſt be diſſolved in *aqua fortis*, as when ſome chymical preparations are made on metals: ſometimes it is neceſſary to *boil them together*, as ſugar and honey, with juices, decoctions, and infuſions, to make *ſyrups*, and ſeveral other compoſitions: ſometimes there muſt be a conſumption of the humidity at a ſlow fire, after the mixture, as in the preparation of ſome electuaries. Sometimes they muſt be mixed together with the biſtorter, as pulps and powders in ſugar and honey: ſometimes they muſt be liquified together, as wax, roſin, and pitch with oils: ſometimes they muſt be melted by a violent fire, as metals, and ſeveral minerals, which are put in fuſion together: ſometimes they are amalgamated, as *mercury* with gold and ſilver.

3. An order muſt be obſerved in the mixture of the

the drugs; for ſome muſt be mixed before the others; for example, in the compoſitions, the pulps muſt be mixed before the powders, and the powders before the eſſences; odorous and volatile ingredients muſt be commonly left for the end, leſt their virtue ſhould be altered by heat and agitation; the ſcammony, aloes, and other gums clotten in the electuaries, if they be mixed while the matter is yet too hot, therefore one muſt wait till it be almoſt cold: the wax and pitch are not to be mixed or melted in plaiſters, till the litharge or minium, or ceruſs, if it enters into them, be done.

When *tablettes* or *lozenges* are made, where no acid enters, the liquor muſt be mixed at once with the ſugar to make them boil together; but if it be wanted to prepare *acid lozenges*, as thoſe of barberries, of lemon, of pomegranates, the juice ought not to be mixed but by degrees with the ſugar over the fire, and dried in proportion; for if the juice that is to be employ'd in it was put all at once, one could not give the mixture by coction, conſiſtence enough to form lozenges of it; for when it is wanted to make the *ſal-polychreſt*, the ſulphur is mixed with the ſaltpeter before the matter is thrown into the red-hot crucible, and in the preparation of ſal prunellæ, the ſaltpetre is put into fuſion, before the ſulphur be mixed with it.

4. The compoſition muſt be of a good conſiſtence, kept in a dry place; and if it be liquid, as electuaries, muſt be ſtirred, from time to time, with a ſpatula, to give room for the fermentation.

A DECOCTION, of the Latin *decoquere*, *to boil*, is made to diſſolve the action and uſeful ſubſtances of a mixt into a proper liquor; or to ſoften thoſe mixts, ſo that a pulp may be extracted from them.

The *liquors* uſed for *decoctions*, are *water*, *wine*, *vinegar*, *milk* and *whey*.

The more hard and compact the drugs are, the more liquor is wanted to boil them. And a *decoction* muſt be ſometimes preceded by infuſion, that the liquor may have time enough to extract the ſubſtance of the mixts; as in the decoction of the woods, viz. *ſarſaparilla*, *china*, *ſaſſafras*, *guaiac*, and *box*.

One muſt avoid, as much as poſſible, boiling the aromaticks, becauſe their volatile principles, which are the moſt eſſential, are diſſipated in boiling: therefore it is beſt to put them in a hot liquor to infuſe, in a veſſel well covered.

When we make a *decoction* of ſeveral ingredients, we muſt begin, for example, by boiling the barley, the chips of hartſhorn and ivory, the roots of gramen, for half an hour at a moderate fire; putting afterwards the other roots newly gathered (well waſhed and picked of their hearts or ſtrings, and cut in ſmall pieces) to boil for a quarter of an hour; proceeding to the fruits after they have been pared and ſtoned, and cut in pieces, if they be large; then the herbs chopped, and the ſeeds bruiſed; concluding with the flowers and liquorice, which muſt be boiled but very little: the whole is thrown afterwards into an earthen pan, or pewter baſon, over the cinnamon bruiſed, the ſanders, the ſaſſafras raſped, and the other aromaticks; the veſſel then is covered; and when the *decoction* is cool, it is ſtrained, and afterwards left to ſettle, that it may be decanted clear.

If animals, as craw-fiſh, frogs, or vipers, are to be in the decoction, they muſt be always put in at the beginning; but then the decoction is to be made over a ſlow fire, leſt there ſhould be a too great diſſipation of the eſſential and volatile ſalts.

Let our firſt preſcription be for a *caphelick decoction*.

Cephalick decoction—Take miſſeltoe and cloves, of each ſix drachms; of juniper-berries three ounces; flowers of ſage, of betony, of marjoram, of each a handful; and let them be boiled, according to the above directions, in three quarts of common water, *i. e.* river-water, which is always beſt for all ſorts of decoctions.

The juniper-berries muſt be bruiſed, and when, together with the flowers, they have boiled two or three gallops, the decoction muſt be thrown into an earthen pan, and well covered till it be cold.—It cannot be kept longer than two days in hot, and four in cold weather.

Virtues.—For the epilepſy, apoplexy, lethargy. *Doſes.*—From two ounces to ſix.

A *pectoral decoction.*—Take two ounces of jar-raiſins ſtoned, fifteen dates, two ounces of jujubes, an ounce of pearl-barley; let the whole boil in three pints of common water to the conſumption of a third part, and towards the end of the coction add half an ounce of liquorice bruiſed, the leaves of maiden-hair, ground-ivy, and tuſſilago, of each a handful; let the whole macerate together for the ſpace of a quarter of an hour, and then ſtrain the decoction.

The raiſins and dates muſt be ſtoned, and the jujubes choſen very freſh; and in ſtraining the decoction it muſt be done with expreſſion.

Virtues.—It is proper to excite expectoration, for an inveterate cough, and to looſen the tenacious matters, which obſtructing the bronchia of the lungs ſtops the reſpiration. *Doſe.*——From two ounces to ſix.

A *bitter decoction.*—Take the tops of little centaury, the leaves of agrimony, flowers of camomile, of each half a handful, two drachms of gentian-root, of ſeeds of carduus benedictus, and of lemon,

of each a drachm and a half; white wine and ſpring water, of each a pint and a half; let it boil till it be reduced to half.

The ſeeds muſt be bruiſed, the gentian-root cut in ſmall pieces, and boiled together in the water, then the ſummets, the leaves, flowers, and white-wine, ſhall be added to it, and left to boil to the conſumption of half the humidity; afterwards it ſhall be ſtrained by expreſſion. If it be wanted to render that decoction purgative, ſix drachms of ſenna, one of rhubarb, and four ſcruples of ſalt of little centaury, muſt be put to infuſe in it, warm for a whole day.

Virtues.—It is proper to expel intermittent fevers, to kill the worms and purify the blood. *Doſe.*—One glaſs in the morning faſting, and another at night.

We often ſee that the bitter remedies are febrifuge, becauſe the ſaline and ſulphurous ſubſtance which compoſe the bitter, is proper to rarefy and diſſolve the matter, which forms the obſtructions and cauſes the fever.

INFUSION comes from the *Latin* word *infundere*, to ſteep.

Drugs are *infuſed*, either to ſoften them, as when dates are ſteeped in hydromel; or to correct them, to temperate their acrimony, as when the root of *eſula* is put to infuſe in vinegar; or to extract their ſubſtance and virtue, as when ſenna, rhubarb, myrabolans, or agarick, are put to infuſe in common water, or in juices.

The liquors commonly employed for *infuſions*, called in terms of chymiſtry, *menſtruum*, are common and diſtilled waters, whey, juices of plants, rain-water, dew, wines, brandy, ſpirit of wine, diſtilled or not diſtilled vinegar.

To make *infuſions* with prudence and utility, one muſt know the nature of the ſubſtance of the drugs, which are to be infuſed, in order to give them a convenient diſſolvent. All ſorts of liquor is not capable to extract the virtues of all ſorts of mixts. Water, for example, is ſufficient to extract the ſubſtances of the ſenna, rhubarb, tamarinds, &c. but it is not proper to receive thoſe of the jalap, tar, turbith; there are wanted for thoſe reſinous mixts, ſulphurous liquors, as brandy, ſpirit of wine, or others, which ſhould be of a nature to diſſolve the roſines.

The time to be employ'd in *infuſions* is not limited; for, as the mixts are more or leſs hard; and their principles more or leſs difficult to be looſened; there is likewiſe more or leſs time required for it.

The APOZEMS are ſtrong decoctions of ſeveral ſorts of roots, herbs, fruits, ſeeds, and other parts of plants, appropriated in virtues to the maladies, for which they are given: thoſe *apozems* can be render'd purgatives, by making to infuſe in them purgative drugs.

For an *alterating* and *aperitive apozem.*—Take the roots of gramen, of parſley, of aſparagus, and white tartar, of each half an ounce; wild cherries, *Kentiſh* cherries, and dried *French* beans, of each three drachms; the leaves of ſuccory, of parietary, of ſellery, of chervil, of each a handful: let them boil together in three quarts of common water to the conſumption of a third part; and ſtrain it afterwards with expreſſion.

Virtues.—It is proper to raiſe the obſtructions of the liver, of the ſpleen, of the meſentery, and of the matrice; and for the ſtone and gravel.——The *Doſe* is a glaſs full twice a day.

The tartar muſt be coarſely pulverized, the roots well cleanſed, bruiſed, and cut in ſmall pieces, and put together to boil for about half an hour in the water; adding, afterwards, the fruits opened, and the *French* beans bruiſed; and when the decoction ſhall have boiled for a quarter of an hour longer, the herbs hatched muſt be thrown into it; and then it ſhall be left to boil to the conſumption of a third part; and afterwards taken off the fire, and when half cold, ſtrained through a cloth by expreſſion. This is the *apozem.* One may make on this model, *pectoral apozems*, with pectoral drugs; *cephalick*, with cephalick drugs; and *hyſterick*, with hyſterick drugs.

JULEP, or JULEB, is a *Perſian* name, which ſignifies ſweet draughts; the *Greeks* call it ζουλαπιον, and the *Latins julepus*, and *julapium*, or *hydroſaccharum*. It is a mixture of ſyrups, and diſtilled waters, or light decoctions, the preparation whereof is commonly of an ounce of ſyrup, on ſix ounces of water or decoction.

Juleps are made of different ſyrups, and of different liquors, according to the maladies for which they are adminiſtered. They may be render'd four either with acid ſpirits or juices; they are not prepared, but when they are wanted; becauſe they cannot be kept longer than two or three days in winter; and about twenty-four hours in ſummer in a cool place: *juleps* are never mixed with purgatives.

For an *hyſterick julep.*—Take the diſtilled waters of *meliſſa*, and of mugwort, of each two ounces; one ounce of orange-flowers, two drachms of cinnamon; one ounce of mugwort; tincture of caſtor, and oleous aromatick volatile ſalt, of each four drops: mix them well together for a *julep* of one doſe.

Virtues.—It diſſipates the vapours; fortifies, and provokes the menſes.

EMULSION came from the Latin *emulgere*, to milk; for in fact this remedy approaches very near the colour and conſiſtence of milk: it is extracted from almonds, cold ſeeds, or fruits diſſolved in diſtilled water, which are ſtrained hard, and edulcorated with ſugar or ſyrups.

For a *cooling* and *aperitive emulſion.*—Take one ounce of the four cold ſeeds; the ſeeds of althæa and of white poppies, of each one drachm: let them be pounded in a marble mortar, pouring ſlowly over them a quart of decoction of the roots of althæa, and of parſley; ſtrain it by expreſſion; and to the colatura add four ounces of ſyrup of marſhmallows.

Virtues.—It is proper to expel, gently, the ſand from the reins and bladder, to temperate and ſoften the acrimony of the urine, when it proceeds from a clap, or from another cauſe.

POTION comes from the *Latin potare*, to drink. This name can be given to all ſorts of draughts; but in medicine it is moſt commonly reſtrained to certain mixtures of ſeveral powders, confections, electuaries, ſyrups, elixirs, tinctures, eſſences, diſſolved in liquors. There may be prepared *potions* of all ſorts, for each malady in particular; for there are *anodyne*, *emetick*, *ſtomachick*, and ſeveral other potions.

A *cordial potion* is properly a julep, in which have been mixed ſimple, or compound drugs; and powders, and cordial confections.

A *cephalick potion* is a julep, in which have been mixed cephalick remedies.

A *purgative potion* is a purgative medicine, or apozem.

For a *cordial potion.*—Take a drachm of confection alkermes, an ounce of ſyrup of lemons, water of bugloſs, and of carduus benedictus, of each one ounce and a half, mixed together for a potion.

Virtues.—This potion is proper to fortify the heart, and to reſiſt the malignity of the humours. It may be taken all at once, or at different times.

To this potion may be added *ſalt of viper*, diaphoretick antimony, volatile ſalts, and ſeveral other ſuch remedies, according to the intention of the phyſician.

For a *cephalick potion.*——Take one drachm of confection alkermes, a ſcruple of volatile ſalt of hartſhorn, an ounce of treacle water, the water of betony, and marjoram, of each an ounce and a half, mixed together for a potion, which is to be taken by ſpoonfuls.

Virtues.—This *potion* is proper to fortify the brain, for the epilepſy, apoplexy, lethargy, and palſy: the doſe is two or three ſpoonfuls at once.

Several other cephalick drugs may be added to this potion, as the tincture of caſtor, the diaſcordium, and the eſſence of cloves.

For a *potion for the cholick.*—Take one ounce of mint-water, half an ounce of cinnamon water, an ounce of ſyrup of diaſcordium, half the yolk of a new-laid egg, the oil of juniper-berries, the ſpirit of ſal-ammoniac, and of lavender compoſed, of each ten drops, two grains of ſalt of wormwood, mixed together for a potion to be taken by ſpoonful.

Virtues.—This potion cures the windy cholick, and diſſipates winds generated in the ſtomach, for want of digeſtion.

For an *aſtringent potion, to ſtop the vomiting or ſpitting of blood.*—Take an ounce of ſyrup of myrtle, a dram of ſanguis draconis, the eyes of crawfiſh prepared, and ſix drachms of vinegar, mixed together for a potion to be taken by ſpoonfuls.

Virtues.—This potion is aſtringent, proper to ſtop the ſpitting and vomiting of blood, a looſeneſs, and the dyſenteria; for loſſes of blood, for the whites in women, and other immoderate evacuations of the matrice.——The *doſe* is a ſpoonful often repeated.

MIXTURE comes from the latin *miſcere*, which ſignifies *to mix*, though this name appears very general, and can be given to a vaſt number of different ſorts of *mixtures* made in *pharmacy*, it is notſtanding more properly adapted to certain *mixtures* of ſpirits, eſſences, elixirs, and diſtilled waters, which being adminiſtered in a ſmall doſe, produce notwithſtanding the ſame effect of remedies given in a greater volume, and operates ſooner.

For a *diuretick mixture.*—Take an ounce of ſpirit of turpentine; rectified ſalt, dulcified nitre, of each three drachms; ſuccin, and elixir proprietatis, of each two drachms; to be mixed together for a *mixture.*

Virtues.—It is proper for the ſtone, the gravel, the ſuppreſſion of urine, and the nephritick cholick——The *doſe* is from four to fifteen drops in white wine, or a liquor appropriated to the diſtemper.

A BOLUS is a ſort of remedy of the conſiſtence of paſte, which is moſt commonly a purgative, divided into ſeveral parts before it is taken.

The conſiſtence of the *bolus*'s is moſt commonly like that of the electuaries; and the matter thereof different, according to the different indications.

For a *cathartick*, and *aperitive bolus*, for a gonorrhœa. Take half an ounce of confection hamec, a drach of turpentine, half a drach of cream

of

of tartar, and fifteen grains of mercurius dulcis, mixed together for a *bolus*.

Virtues.—It purges both by ſtool, and by urine; and cleanſes the urethra, and ſpermatick veſſels, of the venereal virus.

The GARGARISMS are liquid remedies proper for the maladies of the throat, which is waſhed therewith without ſwallowing them.

For a *gargariſm to ſtop a ſalivation*, excited by the mercury.—Take a drachm of whole barley, plantain's flowers, nuts of cypreſs, pomegranate-peal, flowers of ſumach, of each half an ounce, two drachms of barberries, boil them in common water and red wine, a pint of each, to the conſumption of a third part; ſtrain them, and in the colature, diſſolve two drachms of extract of mars aſtringent, half a drachm of ſalt of ſaturn, and two ounces of honey of roſes, for a *gargariſm*.

The barley muſt boil firſt in the water, then the pomegranate-peal, the barberries, and the nuts of Cypreſs bruiſed are added to it, and afterwards the wine; and when the decoction has boiled ſtill a little longer, the herbs and flowers are thrown into it, the coction continuing till the diminution of a third part; then it is ſtrained by expreſſion; and in a pound of the colature, the honey of roſes, the extract of mars aſtringent, and the ſalt of ſaturn are diſſolved.

Virtues.—This *gargariſm* is very aſtringent, proper to dry the ulcers of the mouth, to faſten the gums, and to ſtop a ſalivation when the patient waſhes often his mouth with it.

The ERRHINA, in latin *naſalia*, are remedies introduced into the noſe, to make one blow his noſe or ſneeze. They are made of various forms, ſometimes in powder, ſometimes liquid, ſometimes like a ſort of unguent, and ſometimes in a ſolid maſs, divided into ſmall pyramidical ſticks.

For a *ſternutatory powder*.—Take white hellebore, tobacco, iris of Florence, each two drachms, flowers of lilies of the valley, of betony, of marjoram, and of ſage, of each a drachm.

The drugs muſt be pounded together in a braſs mortar, and afterwards paſſed through a common coarſe ſierce.

Virtues.—It is proper to excite ſneezing and to purge the brain.

A ſcruple of euphorbium may be added to it, when uſed in the apoplexy or lethargy, but in all other occaſions it is dangerous to introduce *euphorbium* into the noſe, becauſe of its violent effects.

INJECTION is a liquor introduced by means of a ſyringe, into ſeveral ſmall cavities of the human body; as into the natural parts of both ſexes, into wounds, and even into the inteſtines; for the clyſters are a kind of *injections*: the matter of the *injections* are different, according to the different indications.

For *an injection to ſtop a gonorrhœa*—Take plaintain and roſe-water, of each four ounces; an ounce of honey of roſes; a drachm of vulnerary and ſtyptick tincture, mixed together for an *injection*.

Virtues.—This injection is aſtringent, proper to ſtrengthen the ſpermatick veſſels, and ſtop the gonorrhœa.

CLYSTER, or *clyſmus*, or *enema*, are *Greek* names, the two firſt ſignify waſhing, and the laſt *injection*.

For an *emollient and laxative clyſter*.—Take two pints of the cooling and emollient decoction; an ounce of lenitive electuary; two ounces of honey of violets, mixed together for a *clyſter*.

Virtues—It is proper for thoſe who are hard-bound, to purge the lower abdomen of bilious and other humours, to temperate the heat of the entrails, and appeaſe the fever.

Whey may be uſed inſtead of the decoction, to render the *clyſter* ſtill more cooling.

For a *deterſive clyſter*.—Take a pint of a deterſive decoction half an ounce of double catholicon, two ounces of honey of roſes, and the yolk of a new-laid egg, mixed altogether for a deterſive clyſter.

Virtues.—It is proper to purge in ſtopping a looſeneſs, and inſtead of the double catholicon, we may preſcribe oil of ſweet almonds, or of white lilies, eſpecially when the looſeneſs is accompanied with ſlimy matters, which cauſe continual motions.

For a *clyſter for the nephritick*.—Take the leaves of marſh-mallows, and parietary, of each a handful, flowers of St. John's-wort, and of the golden rod, of each as much as one can hold between three fingers, three drachms of juniper berries, and two drachms of linſeed, boil them together in a quart of common water, to the conſumption of half the humidity; ſtrain them with expreſſion, and in a pint of the colature, diſſolve lenitive electuary, laxative bendict, of each half an ounce; two ounces of honey of violets; two drachms of turpentine of *Venice*; and ſix drachms of linſeed oil. For a *clyſter*.

Virtues.—It is proper to open the paſſages of the urine; and to cure the nephritick and windy cholick.

The decoction is ſometimes made with white wine; and the *clyſters* with oil or greaſe, purge leſs than thoſe where there is none; becauſe oily ſubſtances

ſtances blunt by their ramous parts the points of the purgatives.

SUPPOSITORIES are ſolid remedies, of a pyramidal figure, and of the thickneſs and length of the little finger. They have been invented to ſupply the want of *clyſters*. This remedy is proper to open a little the body; it is thruſt into the fundament, and kept there as long as poſſible, that it may have time to penetrate and ſoften a little the matters, and provoke the inteſtine *rectum*, by pricking it; but it is very far from having the ſame efficacy as a clyſter.

The common matter of *ſuppoſitory*, is common honey, boiled to a ſolid conſiſtence; it is ſharpen'd with a little ſalt. When the *ſuppoſitories* are to be ſtronger, there muſt be added either half an ounce of electuary of *hiera picra*, or two drachms of aloes.

The honey and ſalt muſt be put in an iron ladle, or in a little ſkillet, over a ſlow fire, where they muſt boil till the matter has acquired a ſolid conſiſtence, which will be known if a little bit thereof be put to cool; then it muſt be poured boiling hot on the bottom of a little mortar turn'd upſide down; and the *ſuppoſitories* formed on a marble, or board greaſed with oil.

PESSARIES are alſo ſolid remedies, very near of the bigneſs of a finger, and of a pyramidal figure; they are introduced into the matrice, after an end thereof has been faſtened to a ribband, that the *peſſary* may be taken out at pleaſure.

Peſſaries can be made of cork, or of a light wood, or with a root, or with a little ſheath made of a thin ſilk, and filled with powders incorporated with wax, oil and cotton, the whole preſſed very hard in the ſheath, that it may have ſolidity enough to be introduced into the matrice: one muſt take care, likewiſe, that the ſeam be very even, and well flatten'd, leſt it ſhould wound the matrice. That made of wood, or of cork, or of root, muſt be anointed with a linament compoſed of drugs appropriated to the intention of the phyſician; for example, if it be to provoke the *menſes*, the following liniment is very proper.

A *liniment* for *peſſaries*.—Take myrrh and aloes, of each a drachm; a ſcruple of ſaffron; eight grains of camphire; four grains of caſtoreum, pound them well together, and mix them in an ounce and a half of unguent of *althæa*, or marſh-mallows. Add to it two drachms of *ſperma ceti*; and ſix drops of oil of ſuccin; for a liniment.

If it be to ſtop a too great a flooding of the menſes, the following liniment is very good.

A *liniment for aſtringent peſſaries*.—Take prepared coral, and *terra ſigillata*, of each two drachms; ſix grains of ſolid *laudanum*, pounded, and mixed together in two ounces of white wax, and an ounce of oil of ſolanum, in which is dipped a ſufficient quantity of cotton for a hard mixture, proper to fill the little ſheaths of ſilk.

A FOMENTATION is moſt commonly made of decoctions of emolient and cooling herbs, to ſoften ſome hardneſſes formed in the lower abdomen, or of aſtringent liquors, to ſtrengthen and bend the fibres: pieces of cloth are dipped in thoſe *fomentations*, kept hot, and applied on the afflicted part; or the herbs are put in ſmall cloth-bags, and after they have been made to boil, are applied. There are alſo *dry fomentations*, made on ſeveral parts of the body; as fried bran or oats, which are applied hot, between two cloths, for rheumatical pains; vervein fried for the pain in the ſide, in the pleurify; parietary to be applied on the region of the urethra, in the nephritick cholick: a hog's bladder is filled with hot milk, and applied on the lower abdomen: ſalt and aſhes are calcined to be applied hot on the neck, to dry and diſſipate the catarrhea's. Laſtly, one may uſe almoſt as many ſorts of *fomentations*, as there are different ſorts of maladies, which afflict the human body.

For a *fomentation for diſlocations and contuſions*.—Take roſemary, ſage, marſh-mallows, hyſſop, and lavender, of each a handful; the rind of pomegranate, bays, and juniper-berries, of each an ounce; fill ſmall linen bags with thoſe herbs, *&c.* bruiſed and mixed together; and put them to boil in two quarts of lees of red wine over a ſlow fire, the veſſel cover'd, to the conſumption, of a third part; then apply the bags hot on the part.

Virtues.—This *fomentation* is proper to ſtrengthen and conſolidate diſlocated bones, the nerves and ligaments; to reſolve the tumours, which follow thecontuſi ons; and to help the digeſtion, when applied on the ſtomach.

The decoction muſt be half cold before it is uſed, then one of the bags is taken out, ſqueezed a little between the hands, and applied on the part, where it is left about an hour; then is taken off, and the other put in its place; continuing to apply thus the bags, alternatively five or ſix times; leaving that, which is applied laſt, five or ſix hours on the part.

EMBROCATION is an aſperſion made of ſome liquor, by means of tow or ſpunges on ſeveral parts of the body, and particularly on the head, to open the pores, and to ſtrengthen.

An *embrocation* is properly a lotion, moſt commonly compoſed of decoctions, or ſpirit of wine,

or

or of oxyrrhonodians, prepared with oil and vinegar of roſes, on the ſhaved head of the patient, as well to prevent a delirium, as to cure it.

For an *embrocation for a lethargy*.—Take the roots of Cypreſs, of iris of *Florence*, calamus aromaticus, of each half an ounce; of leaves of ſage, of roſemary, and of betony, bays-berries, and coriander and cumin-ſeeds, of each two drachms; boil them in three pints of common water to the conſumption of a third part, then ſtrain them by expreſſion, and to the colature add four drachms of brandy; for an *embrocation* for the head.

Lotion comes from the verb *lavare*, to waſh. I'll treat here only of the *lotions*, made to ſome parts of the body in particular, with medicinal liquors, to kill the vermine, &c.

For a *lotion to kill lice in the head*.—Take two ounces of ſtaphyſagria, an ounce of ſemen contra, the leaves of wormwood, of betony, and of little centaury, of each two handfuls: boil them in two quarts of water, to the conſumption of a third part, ſtrain it, and waſh the head with it, warm. It kills the lice and crabs. This decoction can alſo be made in urine, adding to it an ounce and half of the roots of enula campana.

For a *lotion to render red hair black*.—Take half a pound of the peel of green walnuts, the bark of oak, galls, of each two ounces; the leaves of myrtle tree, of pomegranate-tree, of each a handful: boil them in three pints of water to the conſumption of a third part; ſtrain hard the decoction, and in the colature diſſolve roch-alum, and green vitriol, of each an ounce and a half for a *lotion*.

Though this lotion belongs more properly to dying than to medicine; it will, notwithſtanding, pleaſe thoſe who having red hair want to make them change colour; which may be done by waſhing them with this ink, and letting them dry before they are wiped.

A mucilage is ſometimes a ſlimy liquor, which ſpins when it is poured, and ſometimes a ſize. It is commonly made of roots of althæa, of ſymphitum, of the ſeeds of lin, of fenugreek, quinces, or pſyllium, the gums tragacanth, Arabick, or of plumb-tree, the glue of fiſh, the ſkin of a ram infuſed, or boiled in water. All *mucilages* are ſoftening.

For *a common emolient mucilage*.—Take four ounces of the roots of marſh-mallows; the ſeeds of lin and fenugreek, of each an ounce; let them infuſe for twelve hours in two quarts of warm water, then boil them over a ſlow fire, to the reduction of half the humidity, and ſtrain afterwards the mucilage with expreſſion.

Virtues.—This *mucilage* is proper to ſoften the hardneſs, to appeaſe the pains and to ſweeten.

Epithema is a *Greek* word, which ſignifies *fomentation*.—There are two ſorts of *epithems*, one *liquid*, and the other *ſolid*.

The *liquid epithema* is a ſort of fomentation more ſpirituous than the others, which are uſed only for the regions of the heart and liver. Simple and compound diſtilled waters, light decoctions, vinegar, lemon-juice, are the common matters of the liquid *epithems*.

A *ſolid epithem* is a mixture of treacle, confections, mithridate, opiate of ſolomon, diaſcordium, conſerve of roſes, of gillyflowers, bugloſs, &c. of the cordial powders, as the diamargaritum, diarrodon, diatriaſantali, and even the compoſed oil of ſcorpion of Mathiol, ſpread moſt commonly on a piece of ſcarlet cloth, or on leather, and applied about the region of the heart to ſtrengthen it.

For a *liquid cordial epithem*.—Take the waters of bugloſs, of ſcabious, of carduus benedictus, and of roſes, of each three ounces; treacle and confection alkermes, of each half an ounce; and two drachms of the powder diarrodon abbatis, mixed together for an *epithem*. One muſt have two pieces of ſcarlet or other cloth, large enough to cover the region of the heart or that of the liver; and having warmed the epithem in a diſh, the pieces of cloth muſt be ſoaked in it, and applied every quarter of an hour, one after another, as preſcribed in the fomentations, covering the *epithem* with ſome thick cloth, to entertain the heat as long as poſſible.

Virtues.—This *epithem* is proper to revive the heart, and ſtrengthen it, to awake the ſpirits, and reſiſt the malignity of the humours. To this *epithema* may be added ſuch cordials as are judged proper.

For a *ſolid epithema*.—Take an ounce of conſerve of roſes, confection alkermes, and treacle, of each two drachms; for a ſolid epithema, which muſt be ſpread on woollen cloth, and applied warm on the region of the heart.

Virtues.—This *epithema* is ſuppoſed to ſtrengthen the heart by rarefying the blood, and facilitating its circulation.

Perfumes in medicine, may be divided into *liquid* and *dry perfumes*:—*Liquid perfumes*, are all the fragrant waters and caſſoletes.—*Dry perfumes*, are paſtilles, juniper-berries, and the wood of juniper, &c. which are burnt in the chambers of patients, to correct the bad air.

A *powder for a corroborative perfume*.—Take three

three drachms of troches of nutmegs; *calamus aromaticus*, cinnamon, ſtorax, benzoin, of each a drachm and a half; mace, cloves, of each half a drachm; roſes, marjoram, of each two ſcruples, all coarſely pounded together for a *perfume*, to be burnt on lighted coals, for the patient to take the vapour thereof.

Virtues.—It ſtrengthens the heart, and recreates the ſpirits.

A FRONTAL is a remedy applied on the forehead, to appeaſe a little the head-ach, and provoke ſleep. It is ſometimes compoſed of dried remedies, as roſes, ſanders, betony, marjoram, coriander-ſeed, elder-flowers, and of nenuphar; of lavender, kernels of peach-ſtones, or of apricocks bruiſed, when it is wanted to rarefy a coarſe pituita, and ſtrengthen the brain.—Sometimes with wet linen dipped in roſe-water, and vinegar of roſes, to ſtop the bleeding of the noſe; ſometimes with unguents, leaves of green plants, of gourd, lattuces, porcelain, vine; of green flowers pounded, of conſerves, of opium, to provoke ſleep, and moderate the head-ach, which accompany a violent fever.

A *liquid frontal.*—Take lattuces, conſerve of roſes, and nymphæ, of each half an ounce; three drachms of populeum; a drachm of ſea-ſalt, half a drachm of liquid laudanum; to be mixed for a *frontal.*

Virtues.—It is proper to appeaſe a violent head-ach and to provoke ſleep.

COLLYRES are remedies deſigned particularly for the maladies of the eyes.

Collyres are either *dry* or *liquid.*

Dry Collyres are the troches of *rhaſis*, prepared tutty, ſugar candy, iris, white vitriol in powder, which is blown thrown a ſmall pipe into the eye, to diſſipate the cataracts in their beginning.

Liquid collyres are compoſed of ophthalmick waters and powders, as prepared tutty, diſſolved in water of roſes, of plantain, fennel, and celandine, ophthalmick unguents, are alſo called *collyres*, as the unguent of tutty, and ſeveral others.

For a *cooling collyre.*—Take the waters of plantain, of roſes, and of fennel, of each two ounces; and half an ounce of whites of eggs, to be mixed together for a *collyre.*

Virtues.—It is proper for the inflammations and pains of the eyes, ſoftening and embaraſſing, by its glutinous parts, the acrimonious ſalts, which cauſe that diſorder. A fine piece of linen cloth, or a little bit of thin veal, is imbibed with that *collyre*, and applied on the afflicted eye.

A CATAPLASM is an outward remedy, of the conſiſtence of a paſte, compoſed, moſt commonly, of flowers, pulps, oils, unguents, gums, and powders. It is applied on the parts of the human body, ſometimes to reſolve, ſometimes to appeaſe the pains, and ſometimes to raiſe the ſpirits.

For an *anodyne and reſolutive cataplaſm.*—Take four ounces of crumbs of bread, and a pint of new milk; boil them together to the conſiſtence of a *cataplaſm*; then add to it two yolks of eggs, an ounce of oil of roſes; and a drachm of ſaffron well pounded.

Virtues.—It is reſolutive, and proper to appeaſe the pains, and reſolve the tumours, being applied hot on the part: ſometimes a drachm of laudanum is added to this *cataplaſm*, to render it more anodyne.

The DENTRIFICKS, in Latin *dentrificia*, are remedies uſed to cleanſe the teeth, and preſerve them: ſuch are the *woods of lentiſk*, the *ſanders*, the *wood of roſes*, *prepar'd coral*, *burnt bread*, *pumice ſtone*, *cryſtal calcined*, *hart's horn*, *ivory*, and *egg-ſhells*, theſe alkalies mixed, or every one by itſelf, are very proper to cleanſe the teeth, and appeaſe the acrimony of the ſalts left in them after eating. The ſpirits of ſalt and of vitriol, whiten the teeth in a very ſhort time, but they corrode them.

Next comes the preparation of *coral*, *pearls*, *crab's eyes*, *ſpodium*, or *burnt ivory*, *precious ſtones*, *ſuccinum*, or *carabé*, *ſtone hematites*, *load-ſtone*, and ſeveral other ſuch matters.

To prepare well thoſe matters, the *coral*, for example, muſt be pounded firſt, as much as poſſible, in a braſs mortar, then the powder ſhall be thrown on a table of porphyry, to be ground, with a ſufficient quantity of roſe-water. to the conſiſtence of a paſte: that paſte muſt be ground with a muller, till it makes no more noiſe on the porphyry; and then it muſt be formed in little troches, which is the prepar'd coral; which grows paler in grinding, and aſſumes a fleſh-colour; the water mixed with it, ſerves only to grind it more exactly, and with greater facility.

Virtues.—*Prepared coral* is ſuppoſed good to ſtop a looſeneſs, the hæmorrhages and gonorrhœa's.—The *doſe* is from ſix grains to a ſcruple.

The *pearls*, *mother of pearls*, and other *ſhells*, are as hard as the coral, and are attended with the ſame difficulties; and take as much time in their preparation in the mortar, and on the porphyry; but *crab's eyes*, *burnt ivory*, and other ſuch calcined matters, do not require ſo much trituration.

The preparation of the *tutty*, and the *lapis calaminaris*, is different from that of the coral, &c.

no otherwiſe than they are calcined and waſhed before they are pulverized, to carry off their moſt ſaline and ſulphurous parts.

Therefore one may take what quantity he pleaſes of thoſe two drugs, of *tutty*, for example, and make it red-hot in a crucible placed between lighted coals; when red-hot, it muſt be thrown into a baſon full of water, and left there for half an hour; which operation muſt be repeated twice more, changing the water every time: afterwards the *tutty* having been drained, muſt be ground on a porphyry with a muller, mixing with it as much plantain, or roſe-water, as is neceſſary to reduce it to an impalpable powder; then it is formed into ſmall troches.

Virtues.—The *tutty* is deſiccative, and proper for the maladies of the eyes. It is the baſis of the unguent pompholix; it is mixed in the collyres, and in freſh butter: it cleanſes the ſania of the eyes, in drying and fortifying the fibres.

Note, That ſeveral content themſelves with waſhing the *tutty* without calcining it, which does not occaſion a very conſiderable difference,

The *preparation of the bol, terra ſigillata, chalk, litharge* and *ceruſs*, conſiſts in pulverizing the matters, and purifying them of ſome coarſe and terreſtrial parts they contain.

Therefore take what quantity you pleaſe of one of thoſe drugs, for example, of *bol*, reduce it into a ſubtile powder in a braſs mortar, and having put it in an earthen pan, pour water over it, ſtirring the matter, and decanting afterwards gently the water into a veſſel, that the pureſt and moſt ſubtile of the powder may run out with the water: you'll continue to waſh and agitate the matter, and to pour the liquor into another veſſel, till nothing but ſand or another coarſe matter remains at the bottom, which muſt be thrown away; then all the lotions muſt be poured into a funnel garniſhed with grey paper, that the water may be ſeparated from the matter; and then the *bol* remaing ſhall be formed into little troches, which muſt be dried in the ſun.

Virtues.—The *bol* is aſtringent, and proper to ſtop a looſeneſs, hæmorrhages, and gonorrhœa's.—The *doſe* is from ten grains to a ſcruple.

This preparation is not of a great utility, for very little coarſe matter is ſeparated from the *fine bol*, and that impurity beſides could not be capable to produce any bad effect in the body: as for the *coarſe bol*, as it is only uſed outwardly, it is no otherwiſe prepared than by reducing it into a powder, in a braſs mortar.

The *litharge* requires no other preparation than that of the *coarſe bol*, viz. to be put in a ſubtile powder in a braſs mortar.

As for the *ceruſs*, the lotion renders it whiter, and conſequently more proper for the Coſmeticks, and for painting: but for Pharmacy it ſuffices to reduce it into a ſubtile powder.

The *preparation of the lapis lazuli*, for *ultramarine*, conſiſts in ſeparating from the *lapis* the blue, ſaline, and ſulphurous part, from its metallick and terreſtrial part.

Therefore take what quantity you pleaſe of the blueſt *lapis* you can find, without any gold or other veins, pound it in a braſs mortar, then grind it on the porphyry, with a ſmall quantity of common water, till it makes no more noiſe under the muller; this done, mix it in a ſort of paſte made of pitch, wax, and linſeed-oil; this mixture ſhall be waſhed, working it continually in the hands over a marble ſloping, with water, which ſhall be poured over it by degrees, and the lotions received in a baſon placed under the marble; the matter muſt be waſhed thus till it gives no more blue; but the lotions muſt be ſeparated, for the firſt contain the fineſt *ultramarine*; after they have been left to ſettle, the water is decanted gently, and a fine blue powder is found precipitated at the bottom, which muſt be put to drain in a funnel garniſhed with grey paper, then dried; and this is the *ultramarine* uſed by painters: it is alſo uſed in medicine; but as the greaſy paſte it is wrapped in, would give ſome diſagreeable impreſſion to it, one ſhould be contented with grinding it on the porphyry.

Virtues.—The *lapis lazuli* prepared is eſteemed a cordial, proper to reſiſt venom, and to purify the blood; it enters into the confection alkermes.—The *doſe* is from four to fifteen grains.

The *preparation of gum lacca*, conſiſts in purifying it of its terreſtrial parts, by imprinting in it a vulnerary and deterſive quality.

Therefore a decoction muſt be made of two drachms of the roots of ariſtoloch, or *hart-wort*, in two pints of water to the diminution of a third; having ſtrained the decoction, four drachms of gum-lacca bruiſed, but not in powder, muſt be put to boil ſlowly in it, till the pureſt part of the gum may be ſeparated from the fæces, and ſwims a-top, then that pure part muſt be gathered and put to dry in the ſun.

Virtues.—The *gum-lacca* thus prepared, is deterſive, aſtringent, proper to ſtrengthen the ſtomach and the gums: it ſerves alſo as a baſis for ſealing-wax.

The SCAMMONY, which comes from *Aleppo* is eſteemed the beſt; it muſt be choſen the pureſt, the moſt reſinous and moſt friable that can be found, and muſt be reduced into a fine powder.

The

The moſt common method at preſent of preparing the *ſcammony*, is to reduce it into powder, and make it receive through a grey paper, for about a quarter of an hour, the vapour of the ſulphur which is burnt under it, ſtirring it gently from time to time with a ſpatula. It is pretended that this ſulphurous vapour rarefies the glutinous ſubſtance of the *ſcammony*, and hinders it from griping; it is called *diacridium ſulphuratum*.

If the *ſcammony* wants a preparation there is no better than this: — ſteep for about two hours an ounce of liquorice well bruiſed, in eight or nine ounces of warm water; ſtrain the infuſion and mix in it four ounces of good *ſcammony*, in an earthen porringer, which muſt be placed on the ſand, and the humidity made to evaporate at a ſlow fire till the *ſcammony* has reaſſumed its former ſolidity: it is called *diacridium glycyrizatum*, and is a very good purgative. It purges particularly the melancholick humour, and operates without griping.—The *doſe* is from ten grains to a ſcruple. The extract of liquorice mixed in this preparation of *ſcammony*, ſweetens it much; therefore a greater quantity thereof is adminiſtered than that of the other *diacridiums*, even as far as twenty grains, which produce a very good effect.

The *glycirized diacridium* muſt be kept in a bottle well corked, otherwiſe it would grow damp, becauſe of the extract of liquorice.

There is likewiſe a ſyrup made of ſugar, brandy, and ſcammony, by ſetting the mixture on fire; and when the flame is extinguiſhed the mixture is kept for uſe. It purges without griping; and the *doſe* is from one ſpoonful to two.

The *preparation* of the *euphorbium* conſiſts in purifying it and ſoftening it.

Take what quantity you pleaſe of the beſt and pureſt *euphorbium*, reduce it into powder, and having put it in a matraſs, pour over it depurated juice of lemon to the height of four fingers breadth; ſtop the matraſs, and place it in digeſtion at a ſand-heat, ſtirring it from time to time; and the gum being diſſolved, the liquor muſt be ſtrained through a linen cloth, into a glaſs or earthen veſſel, which being placed at a ſand-heat, the humidity is made to evaporate to the conſiſtence of an extract. This is the *euphorbium* prepared, which muſt be kept in a pot.

The *euphorbium* muſt be humected with ſome lemon juice, while pounding, to avoid being incommoded by it; for the little quantity thereof which enters the noſe or the eyes, cauſes in them an inſupportable acrimony and heat.

I diſapprove much the uſe of the *euphorbium* for the inſide.

The *preparations* of the *onions of ſcylle*, conſiſts, 1. In drying them, to deprive them of their hurtful and ſuperfluous humidity: 2. In boiling them, to extract the pulp thereof.

For the firſt, you muſt take *onions of ſcylle*, of a moderate bigneſs, ſound and well fed, then you'll take off with a wooden knife the rind or firſt red and dry leaves, which are to be thrown away; taking afterwards the whitiſh laminæ, and leaving the heart and roots as uſeleſs; which laminæ muſt be dried in the ſun.

For the *ſecond*, the *onions of ſcylle* muſt be wrapped in common paſte, and put in the oven till they are grown ſoft, which is known by introducing a little picked ſtick into them; then the paſte muſt be ſeparated from them, and the pulp of the *ſcylle* taken out, to be made in troches of *ſcylle*.

Virtues.—The *ſcylle* enters ſeveral compoſitions, it rarefies and incites the pituita; it is uſed in the epilepſy, in the aſthma, and to reſiſt venom.

The *preparation* of the *millepedes*, and other ſuch inſects, conſiſts in drying them in the ſun, to preſerve them, and reduce them into powder when they are wanted.

The *millepedes* are killed in white-wine, or in water ſharpened with ſalt; then they are dried in the ſun, to reduce them into powder.

Virtues.—The *millepedes* are aperitive, and proper to expel the gravel, the ſtone, for the nephritick, and the retention of urine.—The *doſe* is from one ſcruple to one drachm.

If ſixteen ounces of *millepedes* have been prepared according to the method here deſcribed, they'll weigh after they are dried, but ſeven ounces and a half. The volatile ſalt of *millepedes* is thought to be good to eaſe the excruciating pains of the gout, thoſe of the rheumatiſm, and other maladies which happen to the muſcles and nerves.

The *preparation* of *vipers*, conſiſts in drying them, that they may be eaſily kept.

You muſt chuſe the biggeſt and moſt lively vipers, in the ſpring or autumn, cut their heads, ſkin them, take out their entrails, waſh their trunks in water, and tie them to a packthread, that they may be hung to dry in a dry place, drying their hearts and livers in the ſame manner.

The fat muſt be ſeparated from the inteſtines, and melted gently in a porringer over a little fire, then ſtrained with expreſſion through a fine linen cloth, to ſeparate it from its membranes; and being cold, muſt be poured into a bottle to be kept for uſe. It is liquid like oil, becauſe of the quantity of volatile ſalt it contains, which exceeds much that of the fat of other animals.

When the trunks, hearts, and livers of vipers are to be kept long whole, it is very proper to

anoint them ſlightly with balſam of *Peru*, for it hinders the worms from getting into them.

The *powder of vipers* is made, ſometimes, in pulveriſing the trunks of the vipers alone; and ſometimes with the addition of the livers and hearts: that done, in this laſt manner is beſt; but it cannot be kept ſo long, as when made with the trunks alone, becauſe the livers and hearts being oily make it grow rank, and worms are generated in it.

Virtues. — It is pretended that the *powder of vipers* is proper to purify the blood, to expel the bad humours by perſpiration, to reſiſt venom, for intermittent and malignant fevers, the ſmall-pox, and the plague.—The *doſe* is from eight grains to two ſcruples.—The *liver* and *heart*, put together in powder, is what we call *mineral bezoard*.—The *doſe* is from ſix grains to a ſcruple.

The *fat of vipers*, is proper to rarefy the humours, and to excite perſpiration: it is preſcribed in malignant fevers, and in the ſmall-pox.—The *doſe* is from one drop to ſix.—It is alſo uſed outwardly to reſolve tumours.

Next comes the *preparation of hartſhorn, ivory, human cranium*, &c.

Thoſe parts of animals having no bad qualities, and their ſubſtance being of a nature to be eaſily diſſolved in the ſtomach, they want no other preparation than that of being raſped and pulverized; all others invented to refine on this, render, it is true, the parts of animals alkaline, and more aſtringent, but deſtroy at the ſame time what they have beſt; for the fire in the calcination diſſipate their volatile ſalt and oil, in which conſiſted their principal virtue.

From this I'll paſs to the *preparation*, or purification of ſeveral *gums*, which cannot be eaſily reduced into powder, as the *galbanum*, the *gum ammoniack*, *opoponax*, and *ſagapenum*.

You may take what quantity you pleaſe of one or ſeveral of theſe gums, break them in ſmall pieces, and put them to ſteep for ſome hours in vinegar, where they muſt be melted over a ſlow fire: the diſſolution muſt be ſtrained with a ſtrong expreſſion; and the grounds left put in new vinegar to perfect the diſſolution of the gum; this diſſolution muſt be ſtrained like the firſt, and mixed with it in an earthen pan, which muſt be placed over the fire, to make the humidity thereof to evaporate to the conſiſtence of plaiſter; and thus you'll have the gums purified.

Virtues.—They are proper to ſoften, to reſolve, to help ſuppuration, to abate the vapours, they are applied on the navel, and on tumours.

When thoſe gums are to be pulveriſed, one muſt chuſe the fineſt and cleareſt, and make them dry gently between two papers, in the ſun, or at the fire. They are eaſily reduced into powder, when mixed with other drugs.

Juices are liquors, which flow, ſometimes, ſpontaneouſly, or which are extracted from vegetables, either by inciſion, or expreſſion; ſome are alſo extracted from animals, but under other names.

Juices extracted by inciſion are purer and better than thoſe extracted by expreſſion; becauſe the expreſſion makes a great deal of terrene parts flow together with the liquor.

To extract a *juice* by inciſion, there are inciſions made in the plant, or in the root, and through thoſe apertures flows by degrees an humour, which is made to evaporate, either in the ſun, or at a ſlow fire; in that manner the aloes ſuccotrina, the ſcammony, and the ſanguis draconis are prepared.

Juices are *extracted by expreſſion*, by pounding a plant or ſome part thereof in a mortar, and ſqueezing it hard; for then a liquor comes out of it, which can be made to thicken, either in the ſun, or at the fire: in this manner are extracted the aloes cabalin, the meconium, which we callopium, the acacia, the hypociſtis, and the elaterium.

A greater quantity of juice is extracted from the plant, if before the expreſſion it be left ſome hours in digeſtion, than if it was put to the preſs ſo ſoon as it is pounded, becauſe in the digeſtion the juice is looſen'd, and becomes leſs viſcous.

There is more difficulty to extract the juice of viſcous plants, as of the borage, bugloſs, *&c.* than of others; and it is proper to warm them before they are put into the preſs.

When *juices* are to be kept in liquor, they muſt be depurated, either by boiling them a little, and ſtraining them; or leaving them expoſed one day or two to the ſun, and decanting them ſoftly afterwards, from their ſediment. Then bottles muſt be filled with it to the neck, putting ſome ſweet oil a-top, to the height of two fingers breadth. That oil hinders the external air from penetrating into it, and conſequently its being corrupted; it may be kept good by that means at leaſt a whole year.

For the *preparation of the black juice of liquorice*, commonly called *Spaniſh liquorice*. Take two pounds of extract of liquorice, half a pound of white ſugar; gums tragacanth and arabick, of each four ounces: mix the whole together for a maſs, to be formed into rotules.

To make the extract of *liquorice*, you muſt ſcrape and bruiſe a quantity of green or dry *liquorice*, and having ſtrung it, put it into a large earthen pan, pour hot water over it, and leave it in digeſtion

digeſtion over a ſlow fire, for ſeven or eight hours; then the infuſion muſt be ſtrained with expreſſion, and the *liquorice* put again to ſteep in other hot water, which muſt be ſtrained as before, and both colatures mixed together, and the humidity thereof made to evaporate over a ſlow fire to the conſiſtence of extract. This is the beſt *extract of liquorice* that can be made, but it cannot be kept in form of rotules, becauſe it grows damp eaſily, and has beſides a diſagreeable taſte. Therefore to give it ſome form, and an agreeable taſte, the ſugar and gums mentioned in the deſcription, muſt be mixed with it; which to do, one muſt bruiſe gums tragacanth, and arabick, of each four ounces, and put them to ſteep in about three pints of warm water, till they be diſſolved into a mucilage; the whole muſt be ſtrained through a proper ſieve, and the colature having been mixed with the ſugar and extract of *liquorice* in an earthen pan, the whole muſt be placed over a ſlow fire, to evaporate the humidity of the mixture, ſtirring it continually with a ſpatula, till it be reduced to the conſiſtence of an extract or hard paſte, of which will be form'd magrotules to be kept for uſe.

Virtues:—The *Spaniſh liquorice* thus prepared, is an excellent remedy for a cold, and to facilitate expectoration, and to ſoften the acrimony of the breaſt, by leaving a little bit of it to melt in the mouth.

Next comes the preparation of the *rhohob*, *ſapa*, and *defrutum*.

RHOHOB or ROB, is an *Arabick* name, whereby is underſtood the juice of any fruit whatever, boiled to the conſiſtence of honey.

The name of SAPA is only adapted to the juice of grapes boiled.

The DEFRUTUM is nothing elſe but the juice of raiſins, evaporated to the diminution of a third part only.

For the *preparation of the rhohob of mulberries*, or *ſimple diaphorum*. Take four pounds of the juice of *mulberries*, and two pounds of honey ſkimmed; boil them together to a juſt conſiſtence.

You muſt take the *mulberries* before they are quite ripe; pound them in a marble mortar, and extract the juice thereof, which muſt be left to depurate a day or two in the ſun; after which, having been ſtrained, two parts thereof ſhall be mixed with one part of honey, in a glazed earthen diſh; and put to evaporate at a ſlow fire, to the conſiſtence of honey. This will be the *ſimple rhohob of mulberries*, which muſt be kept in a pot.

Virtues.—This *rhohob* is proper for the inflammation of the throat, for the aphthes or little ulcers, which come in the mouth of new-born children. It is alſo very proper to temperate the acrimony of the humours, to cleanſe and conſolidate. This remedy is ſometimes taken alone by ſpoonfuls; but it is oftener mixed in cooling or deterſive decoctions, or proper to the intentions of the phyſician.

A MEDICINAL WINE is a wine impregnated with the ſubſtances and qualities of one, or ſeveral kinds of medicinal drugs.

For the *preparation of the wine of wormwood*.—Take a bundle of the dried ſummits of wormwood in bloſſom, and three ounces of cinnamon bruiſed; put them into about fifty quarts of white wine, newly made, and place the veſſel in the cave, the bung-hole open, and leave it there to ferment: the fermentation over, the veſſel muſt be filled quite, and well ſtopped: then you'll have the *wine of wormwood*.

Virtues.—The *wine of wormwood* ſtrengthens the ſtomach, provokes the appetite, kills the worms, cures the windy cholick, abates the vapours, provokes the menſes, and is very proper for the greenſickneſs.——The common *doſe* is half, or even a full glaſs, for ſeveral days ſucceſſively.

For the *preparation of a magiſtral purgative wine*.—Take ſix drachms of ſenna, cardamum, and ſeeds of violets, of each two drachms; troches of agarick, and the beſt rhubarb, of each a drachm and a half; a drachm of cinnamon, to be infuſed together for 24 hours in a quart of wine; then the colature muſt be preſerved for uſe.

Virtues.—This remedy has a purgative property for pituitous and melancholick conſtitutions; for the palſy, apoplexy, quartan ague, and the ſcarvy.——The *doſe* is a glaſs-full in the morning faſting, which muſt be continued for ſeveral days ſucceſſively.

Three ounces of ſyrup of apples compoſed, may be added to this infuſion, to render it more purgative.

For the *preparation of a febrifuge wine*.—Take two ounces of quinquina or jeſuit's bark, put them to infuſe in a quart of ſtrong white wine, in a matraſs, large enough, that the third part thereof may remain empty; put the matraſs well corked in a warm place, for the ſpace of 24 hours, ſhaking it often during that time; then decant the liquor, leaving the grounds at the bottom.

Virtues.—This wine is an excellent febrifuge for intermitting fevers; by the patient taking half a glaſs of it every four hours, for fifteen days ſucceſſively, in the hours of the intermiſſion: but when the fever is ſtopped, he muſt be contented with one or two doſes every day, to hinder the return of the acceſs.

If this wine be taken a little muddy at firſt, *viz.*

if

if it be ſhaken before it is poured off the grounds, it will ſtop the fever ſooner.

A Medicinal Vinegar is a vinegar filled with the ſubſtances and virtues of one or ſeveral ſorts of drugs, which ſerve in Medicine.

For the *preparation of vinegar of ſcylle.*—Take two or three onions of *ſcylle* well fed and very ſound, pare the outward rind, which is half dried, ſeparate the laminæ with a wooden or ivory knife, throwing away the heart as uſeleſs; cut the laminæ into pieces, put one pound thereof in a large glaſs bottle, and pour upon it four quarts of good white wine vinegar, cork the bottle, and place it in digeſtion at the ſun, where it muſt be left forty days; then the infuſion muſt be ſtrained with expreſſion, and kept in a bottle well corked.

Virtues.—This *vinegar* is eſteemed proper for the epilepſy, to purify the blood, to reſiſt venom, and to expel the wind.——The *doſe* is from one ounce to three. It is uſed likewiſe in gargariſms for the ſquinancy.

Conſerves differ from *condits* in their conſiſtence; for they are prepared into a paſte, whereas *condits* are either boiled whole, or in pieces in the ſugar.

The name of *conſerve* has been juſtly given them, ſince they are made with no other view than to preſerve the parts of the vegetables in all their goodneſs; for the ſugar mixed with them being a ſalt it ſtops the pores thereof, abſorbs their too great humidity, and hinders the air from entring into it, to excite a fermentation, which we call corruption.

It is to be obſerved, notwithſtanding, that liquid *conſerves* ferment for ſome days after they have been made.

For a *ſoft conſerve of roſes.*——Take the buds of roſes before they are quite open, cut off with ſciſſars the white part which is called nail; weigh a pound of thoſe buds thus prepared, and make them boil two or three gallops in three pints of common water, ſtrain the liquor with expreſſion, and pound thoſe roſes thus ſoftened in a marble mortar, till they be reduced to a pulp, and may melt entirely in the mouth; mean while two pounds of ſugar muſt be put to boil in the decoction to the conſiſtence of an electuary; and being then taken off the fire, the pounded roſes muſt be exactly mixed in it, putting again the baſon over a very ſlow fire, and ſtirring continually the *conſerve*, making thereby the humidity to evaporate gently, till it has acquired a reaſonable conſiſtence; then the *conſerve* is put in a pot to be kept.

Virtues.——This *conſerve* is proper to appeaſe a cough, to ſtop hæmorrhages, vomiting, and a looſeneſs; to ſtrengthen the heart and the ſtomach, and to help digeſtion.——The *doſe* is from one drachm to three: it moſt commonly enters the ſolid epithems.

The common method of preparing the conſerve of roſes, is to beat the buds of red roſes cleanſed, as above, with double their weight of ſugar, till the mixture be in form of an electuary, then to put the *conſerve* in an earthen pot, and expoſe it for ſome days to the ſun, till a fermentation enſues, and a more exact union of the parts.

The *conſerve* muſt be made ſo ſoon as the roſes are cut, for if they be left expoſed to the air they loſe part of their beauty. The decoction carries off almoſt all the tincture; but it is no matter, ſince that decoction is uſed to boil the ſugar; the tincture is not loſt in boiling, for when the mixture is made, the conſerve appears, as fine as can be. If ſome drops of ſpirit of vitriol or of ſulphur be mixed in the *conſerve* of roſes, they will heighten its colour, and render it of a more agreeable taſte, but it will turn pale as it grows old.

For the *preparation of a ſolid conſerve of roſes.*—Take an ounce of red roſes ſeparated from their whitiſh part, and in powder; mix it with a wooden ſpatula, with about a drachm of ſpirit of vitriol; boil a pound of ſuperfine ſugar in four ounces of roſe-water to the conſiſtence of tablettes; take the ſugar off the fire, and incorporate with it, with the ſame wooden ſpatula, the powder of roſes; when the matter will be almoſt cold, you muſt throw it by bits on a marble, or a paper anointed with oil, where it ſhall be left to harden, keeping it afterwards in a box.

Virtue.—The ſame virtues are attributed to this *conſerve* as to the liquid, but it has not ſo much. The powder of vitriol the powder of roſes is moiſtened with, renders the *conſerve* more beautiful than it would be, becauſe it extends and rarefies the parts, which give the colour to the roſes.

For the *preparation of the conſerve of juniper-berries.*—Take four pounds of juniper-berries newly gathered, bruiſe them, and put them to boil over a ſlow fire, in a ſufficient quantity of water, and in an earthen pot covered, till they be ſoft; take them out of the decoction, and ſtrain them through a ſieve; boil in the decoction two pounds of white ſugar, to the conſiſtence of ſyrup, then mix with it the pulp of juniper-berries, ſix ounces of the beſt rhubarb in powder, half an ounce of nutmegs, an ounce and a half of the beſt cinnamon, ſix ounces of galanga; calamus aromaticus, ginger, and mace, of each four ſcruples, ſtirring them continually together with a wooden ſpatula, and over the fire, till the conſerve be done; then it muſt be taken off the

the fire, and when cold, put into a pot to be kept.

Virtues.—This *conſerve* is an excellent remedy to ſtrengthen the ſtomach, provoke the urine, and keep the body open.

Preparations of HONEY.

Virtues.——*Honey* opens the body, and is good for the maladies of the breaſt and lungs; hydromels are made of it, which are powerful deterſives; and it is employ'd in clyſters.

For the *preparation of the oxymel of ſquills*, or *ſquills*. Mix in a glazed earthen diſh, three parts of the beſt honey, with two of vinegar of ſquills; put it to boil over a ſlow fire, ſkimming it, to the conſiſtence of ſyrup; it is the *oxymel of ſquills*.

Virtues.—This *oxymel* is proper to incite and attenuate the phlegm faſtened to the lungs, breaſt, and other *viſcera*; it is uſed for the ſquinancies, and for the epilepſy, mixed in lohochs and gargariſms; it is alſo taken in waters appropriated to the maladies, from one drachm to an ounce. It is ſtronger than the ſimple *oxymel* to looſen the phlegm.

For the *preparation of honey of roſes*.—Pound in a marble mortar, red roſes newly gather'd, to the conſiſtence of paſte; leave them in digeſtion for five or ſix hours in a cold place; then carry them to the preſs to extract the juice; weigh that juice, and mix it with the ſame quantity of good honey: clarify the mixture with the white of an egg; then having ſtrained it warm through the flannel, put it to boil to the conſiſtence of ſyrup; and it is fit to be kept for uſe.

Virtues.——It is deterſive and aſtringent; and is employ'd in the gargariſms, for a ſore mouth, and a ſore throat; in aſtringent injections and clyſters.

For the *preparation of the honey of mercurialis*. Mix together an equal quantity of the juice of mercurialis with common honey; boil them, and ſkimming them, to the conſiſtence of ſyrup; ſtrain it through a ſieve turn'd upſide down, and keep it in ſtone juggs.

Virtues.——This *honey* is more purgative than the preceding ones; and is employ'd in clyſters for the windy cholick, and the hyſtericks.——The *doſe* is from an ounce to three.

SYRUPS.

Syrups are properly liquid conſerves of the pureſt ſubſtances of the mixts. They are commonly made with ſugar, rather than with honey, and are clarified to give them a more agreeable taſte and ſmell. An apothecary muſt renew them pretty often, for in growing old, they loſe much of their virtue: it is true, that there are ſeveral of them which cannot be made but once a year; but there are alſo ſeveral others which can be renewed ſeveral times in the year.

The *clarification of ſyrups* is done in the following manner: The white of an egg is put in a baſon with three or four ounces of the liquor, which ought not to be hot, for then the white of the egg would curdle; they are beaten together, for ſome time, with rods, and the whole turn'd into a ſcum, then the ſugar, and the reſt of the liquor, are added to it; that mixture is put to boil two or three gallops over the fire, that the white of the egg, which is viſcous, may load itſelf with the dirt which is in the *ſyrup*, and be ſeparated towards the ſides of the baſon; when the *ſyrup* which boils in the middle appears very clear, it muſt be ſkimmed, and ſtrained afterwards through a flannel; then the clarified *ſyrup* is made to boil to the conſiſtence required, ſkimming it again from time to time if it wants it. When there are more than three pounds of ſugar to be clarified, it requires more than one white of an egg.

The *conſiſtence of a ſyrup* muſt be glutinous, and a little viſcous, forming, when pour'd gently from a ſpoon, big drops when it is moſt out of the ſpoon, and a ſhort ſtring. But *ſyrups* do not all want the ſame coction. Acid *ſyrups*, as thoſe of barberries, gooſeberries, pomegranates, *&c.* keep well enough, though they have received but a ſlight coction, becauſe of their acid ſalt. As to *ſyrups* which have not that acidity, and are to be kept long, they want a ſtronger coction; taking care, notwithſtanding, that they be not too much done, leſt they ſhould candy in cooling, which would oblige the Apothecary to melt them over again in balneo mariæ. The candy is a cryſtallization of the ſugar.

Syrups, made with powder-ſugar, are leſs ſubject to grow candy, than thoſe prepared with loaf-ſugar; becauſe powder-ſugar contains an unctuoſity which hinders it from cryſtallizing ſo eaſily. But to hinder a *ſyrup* from growing candy, one has only but to mix, while it boils, half an ounce of the beſt honey, for each pound of ſugar: it is alſo very proper to ſtir it a little with a ſpoon, while it cools, to hinder it from condenſing at the bottom, and it muſt not be ſhut up in a veſſel, if it is to be kept, before it is quite cold; for it may happen, that when it has been put a little warm in a pot, and cover'd, the humidity, which aſcends in a vapour to the top of the pot, falls back on the *ſyrup*, and makes it grow muſty a-top, and candy at the bottom.

For the *preparation of a ſimple ſyrup of maiden hair*.——Take ſix ounces of the beſt *maiden hair* you can find, and newly gather'd, cut it ſmall, and put it to infuſe in two quarts of warm wa-

ter for ſix or ſeven hours; boil afterwards the infuſion to the diminution of a fourth of the humidity, ſtrain it with expreſſion, and mix three pounds of ſugar in the colature, clarifying the mixture according to the method heretofore preſcribed, ſtraining it through the flannel, and putting it to boil to the conſiſtence of *ſyrup*.

Virtues.—This *ſyrup* is good for the cough, for the maladies of the breaſt, to ſoften the matrice after a delivery, and for the maladies of the ſpleen. A ſpoonful thereof is mixed in juleps, emulſions, and ptiſans. It is given to new-born children, with oil of ſweet almonds, and to women newly delivered.

For the *preparation of a ſolutive ſyrup of roſes.*—Take pale roſes gather'd in the morning, free them of their pecules and calices, pound them in a marble mortar, and having left them a few hours in digeſtion, ſtrain them to extract the juice thereof, which muſt be left to depurate either in the ſun or in ſome other warm place; then pour it by inclination, and having ſtrained it through a flannel, mix with it an equal weight of ſugar, and make the mixture boil at a ſlow fire, to the conſiſtence of *ſyrup*.

Virtues.—This *ſyrup* purges gently the ſeroſities, and other humours in ſtrengthening the ſtomach. —The *doſe* is from half an ounce to two ounces.

For the *preparation of a cathartick ſyrup of buckthorn.*——Take a good quantity of ripe berries of buckthorn; bruiſe them in a marble mortar, where they muſt be left ſome hours in digeſtion, then ſtrained with expreſſion; leaving the juice afterwards to depurate, by being put to ſettle, for ten or twelve hours, in a warm place; and after it has been ſeparated from its fæces by inclination, take ſix pounds of that juice and mix it with four pounds of ſugar, and half a pound of ſkimm'd honey, and put the mixture to boil over a ſlow fire, to the conſiſtence of *ſyrup*; and towards the end of the operation add to it, tied in a piece of linen cloth, three drachms of cinnamon, and two drachms of maſtick, which muſt be left ever after to ſteep in the ſyrup.

Virtues.—This ſyrup is a great purgative, and evacuates principally the ſeroſities; it is preſcribed for the gout, the hydropſy, and for obſtructions. —The *doſe* is from two drachms to an ounce and a half. The patient muſt eat as ſoon as he has taken it; for if he was to abſtain from eating, as it is obſerved after the taking of other purgatives, this ſyrup would be griping; becauſe the buckthorn contains an acid eſſential ſalt, which would prick the membranes of the ſtomach, and of the inteſtines; but the mucilaginous ſubſtance of the aliments ſoftens that ſalt in embarraſſing its points.

For the *preparation of the ſyrup of epithym*, or *doder.*——Take the *doder*, citrine mirabolans, tamarinds, of each two ounces and a half; agarick and ſalt of fumitory, of each ſix drachms: hatch the doder, bruiſe the mirabolans, and diſſolve the tamarinds by degrees in ſome diſtilled water of bugloſs, boiling-hot; then put the whole to infuſe for twenty-four hours in two quarts of the ſame diſtilled water of bugloſs, alſo hot, in a glazed earthen pot and covered: the next day ſtrain the infuſion by expreſſion, and having left it to ſettle for a few hours, pour it by inclination, and mix with the colature two pounds of ſugar, then put the mixture in an earthen diſh, and boil it over a ſlow fire, to the conſiſtence of ſyrup.

Virtues.—This ſyrup is preſcribed to purge the black bile, and the hypochondriacal melancholy, for the leproſy, itch, venereal diſeaſe, epilepſy, cancers, and malignant ulcers.—The *doſe* is from half an ounce to two ounces.

For the *preparation of a ſyrup of ſcammony.*—— Take three drachms of the beſt ſcammony, reduced to a coarſe powder; three drachms of liquorice well ſcraped and bruiſed, put them together in a matraſs, and pour over them a pint and a half of the beſt brandy; ſtop the matraſs, and put it in digeſtion in horſe dung, or in another warm place, for three days, ſhaking it from time to time; afterwards the tincture muſt be filtered, and two pounds of white ſugar having been added to it, the mixture muſt be boiled in an earthen diſh, over a ſlow fire, to the conſiſtence of ſyrup.

Virtues.——This ſyrup is proper to purge the hypochondriacal melancholy, for the lethargy, and apoplexy.——The *doſe* is from two drachms to an ounce and a half. It is a vigorous purgative.

In *three drachms* of this ſyrup, there are *three grains of ſcammony.*—In *half an ounce*, ſix grains of ſcammony.—In *five drachms*, ſeven grains and a half of ſcammony.—In *ſix drachms*, nine grains of ſcammony.—In *ſeven drachms*, ten grains and a half of ſcammony.—In *an ounce*, half a ſcruple of ſcammony.—In *nine drachms*, thirteen grains and a half of ſcammony.—In *ten drachms*, fifteen grains of ſcammony.—In *eleven drachms*, ſixteen grains and a half of ſcammony.—In *an ounce and a half*, eighteen grains of ſcammony.

For the *preparation of a ſolutive ſyrup of violets.* Take two pounds of flowers of violets, whole, and half a pound of ſeeds of violets bruiſed; put them to infuſe for twelve hours in three quarts of boiling water; then boil ſlightly the infuſion, ſtrain it by expreſſion; and in the colature put to infuſe flowers and ſeeds of violets as before; in this ſecond infuſion ſtrained ſhall be reiterated the infuſions and colatures, till the liquor be entirely impregnated with the

the ſubſtance of the violets, which will be known at the violets coming out tinged with the liquor. In the laſt infuſion mix three pounds of white ſugar, clarify the mixture, and boil it to the conſiſtence of ſyrup.

Virtues.——This ſyrup purges the bile and the ſeroſities.——The *doſe* is from half an ounce to two ounces.

For the *preparation of ſyrup of rhubarb.*—Take half a pound of the beſt rhubarb, and ſix drachms of ſoluble tartar; cut the rhubarb in little pieces, and put it with the ſoluble tartar in a glazed earthen pot, pour over it three or four pints of boiling-hot water, cover the pot, and leave the matter in digeſtion for ten or twelve hours, boiling it afterwards ſlightly, and ſtraining it with expreſſion; and the grounds are put back into the pot, and made to ſteep in other boiling-hot water for five or ſix hours; then, after it has been boiled ſlightly, and ſtrained as before, the tinctures are mixed together and left to ſettle; and after they have been filtrated and mixed with three pounds of white ſugar, the whole mixture is put to boil over a ſlow fire to the conſiſtence of ſyrup.

Virtues.—This ſyrup purges the bile, is good for a looſeneſs, and for the worms.—The *doſe* is from half an ounce to two ounces.

For the *preparation of ſyrup of barberries.*——Take the juice of barberries, newly extracted and depurated, and white ſugar, of each two pounds; boil them together over a ſlow fire to the conſiſtence of ſyrup.

Virtues.—This ſyrup is aſtringent and cooling: it is uſed in juleps to ſtop a looſeneſs, to ſtrengthen the heart, and reſiſt the malignity of the humours.—The *doſe* is from half an ounce to an ounce and a half.

For the *preparation of the ſyrup of pomegranates.* Take the juice of ſour pomegranates, newly extracted and depurated; and white ſugar, of each two pounds, mix them together in an earthen diſh; put the diſh over a ſlow fire, and make the humidity of the mixture to evaporate to the conſiſtence of ſyrup.

Virtues.—This ſyrup rejoices the heart, ſtops vomiting, the looſeneſs, the hæmorrhages, and quenches thirſt in cooling.——The *doſe* is from half an ounce to an ounce and a half.

It is not neceſſary to boil the ſour ſyrups as much as others, becauſe the eſſential acid they contain, preſerve them, though they have not the ordinary conſiſtence.

For the *preparation of the ſyrup of quinces.*——Mix in a glazed earthen diſh, equal parts of the juice of quinces, depurated, (by expoſing it two or three days to the ſun, and filtrating it afterwards) and of white ſugar, *v. gr.* two pounds of each; place the diſh over a ſlow fire, and make the humidity to evaporate to the conſiſtence of ſyrup.

Virtues.—The ſyrup of quinces is aſtringent; proper to ſtrengthen the ſtomach, and to ſtop the looſeneſs.——The *doſe* is from half an ounce to an ounce and a half.

If the juice of quinces was employ'd without being depurated, it would make a jelly of quinces inſtead of ſyrup.

For the *preparation of a ſimple ſyrup of poppies.*—Cut in ſmall pieces two pounds of heads of white poppies, newly gather'd, in their maturity, and one pound of heads of black poppies; put them in a glazed earthen pot, and pour over them four quarts of boiling-hot water, cover the pot, and leave the matter in infuſion for 24 hours; boil it afterwards gently to the diminution of half the humidity; ſtrain the decoction with a ſtrong expreſſion, and with the colature mix three pounds of ſugar; clarify the mixture and boil it to the conſiſtence of ſyrup.

Virtues.—This ſyrup is ſomniferous, proper to ſoften the acrimony of the throat, and of the *trachæa*, to appeaſe pains, to ſtop fluxions, a cough, ſpitting of blood, and the dyſentery; it is preſcribed in all the occaſions where it is neceſſary to ſtop the too great motion of the humours.——The *doſe* is from half an ounce to ten drachms.

For the *preparation of the ſyrup of ground-ivy*—Let about nine or ten handfuls of ground-ivy, gather'd in its greateſt vigour, be exactly pounded in a marble mortar; moiſten the matter with eight or nine ounces of warm water; cover the mortar, and leave the matter in digeſtion for ten or twelve hours; then ſtrain it, and having ſlightly boiled the juice, ſtrain it two or three times through a flannel; weigh that juice thus depurated, and having mixed with it an equal quantity of ſugar, place the mixture over a ſlow fire, and let it boil to the conſiſtence of ſyrup.

Virtues.—This *ſyrup* is proper for the maladies of the lungs, and of the breaſt, proceeding from a coarſe pituita, which falls upon them. It is good for the aſthma, to raiſe the obſtructions of the ſpleen, of the liver, of the meſentery, and of the matrix, it provokes the menſes, and is alſo ſudorifick.——The *doſe* is from half an ounce to two ounces.

Ground-ivy is commonly in its vigour in the month of *April* and *June*.

For the *preparation of the ſyrup of hyſop.*—Put to boil in three quarts of water half an ounce of pearl-barley, hyſop, roots of fennel and liquorice, of each ten drachms; ſix drachms of white adiantus; an ounce and a half of jar-raiſins ſtoned; jujubes

and dates, of each thirty; ten figs; the ſeeds of mallows, quinces, and gum tragacanth, of each three drachms; boil them all together to the diminution of a third part of the humidity; clarify the decoction by ſettling; and having mixed with it two pounds of ſugar, let the mixture boil over a ſlow fire to the conſiſtence of ſyrup.

Virtues.—This ſyrup is proper for the maladies of the breaſt, when cauſed by phlegm and obſtructions; it is preſcribed for the aſthma, to provoke urine, and expel the ſand from the reins.——The *doſe* is from half an ounce to an ounce and a half.

For the *preparation of a ſyrup of quinquina.*——Take half a pound of the beſt quinquina, coarſely pounded; put it in a glazed earthen pot, and pour over it two quarts of the beſt white wine; cover the pot and put it in digeſtion in balneo mariæ, or in another warm place, for three days, ſtirring the matter from time to time. Boil afterwards gently the infuſion in the ſame pot, to the diminution of a fourth of the humidity; ſtrain it with expreſſion, and to the colature add three pounds of white ſugar; clarify the mixture, and put it to boil over a ſlow fire, to the conſiſtence of ſyrup.

Virtues.—This ſyrup is febrifuge; it ſtops all intermittent fevers.——The *doſe* is from half an ounce to two ounces, diſſolved in the water of little centaury.

It is more proper to make this ſyrup in an earthen veſſel, than in a copper baſon, to avoid the impreſſion which the ſyrup may take from the copper.

This ſyrup is not to be uſed till after the patient has been well purged, becauſe it fixes the humour. It muſt be given three or four times a day, and the uſe thereof continued for 15 days ſucceſſively at leaſt.

For the *preparation of ſyrup of camomile.*—Take one pound of camomile flowers, newly gathered, put one third of thoſe flowers to infuſe in two quarts of ſpring-water, boiling hot, for twelve hours; which expired, boil ſlightly the infuſion, ſtrain it by expreſſion, and in the colature put to infuſe the ſame quantity of new flowers, for the ſame ſpace of time as before, boiling, afterwards, and ſtraining the infuſion in the ſame manner; repeating the ſame proceſs a third time, with what is left of the pound of flowers; but in the laſt colature mix three pounds of the beſt ſugar, clarify the mixture, and put it afterwards to boil over a ſlow fire, to the conſiſtence of ſyrup.

Virtues.—This ſyrup is excellent for the windy cholick, and to provoke the menſes.—The *doſe* is from half an ounce to an ounce and a half.

For the *preparation of the ſyrup of mint.*—Take the juices of quinces, and of pomegranate, of each two pounds, put to infuſe in them for twenty-four hours, eight ounces of mint pounded, and two ounces of red roſes; then put the infuſion to boil ſlightly, ſtrain it afterwards with expreſſion, and mix in it three pounds of white ſugar, and having clarified the mixture, put it to boil over a ſlow fire to the conſiſtence of ſyrup; which is to be aromatiſed with two drachms of the troches of *gall a moſchata*, tied in a piece of linen cloth, and twelve drops of oil of mint.

Virtues.—This ſyrup is proper to ſtrengthen the ſtomach in faſtening the fibres; to ſtop vomiting, nauſea's, hickups, and the lienteria.—The *doſe* is from half an ounce to an ounce and a half.

For the *preparation of the ſimple ſyrup of ſcordium.*—Take two pints and a half of the juice of ſcordium, two pounds of white ſugar, and ſix drachms of the ſalt of ſcordium; clarify the mixture, and boil it over a ſlow fire, to the conſiſtence of ſyrup.

Virtues.—This ſyrup is uſed againſt the plague, the malignant fevers, and the worms; it provokes perſpiration and the menſes.—The *doſe* is from half an ounce to an ounce and a half.

For the *preparation of the compoſed ſyrup of ſcordium.*—Take a quart of the ſimple ſyrup of ſcordium, mix in it half a drachm of the volatile oleous aromatick ſpirit, camphire diſſolved in two drachms of ſpirit of wine, and muſk, of each half a ſcruple, tied in a piece of linen cloth, for a ſyrup.

Virtues.—This ſyrup is uſed for malignant fevers, and other maladies proceeding from the corruption of the humours.—The *doſe* is from half an ounce to an ounce and a half.

For the *preparation of the ſyrup of kermes.*——Pound in a marble mortar the grains of kermes, when they are very ripe and very red; leave them in a cold digeſtion for ſeven or eight hours, to rarefy a little their viſcous ſubſtance; then put them in a ſtrong linen cloth, and carry them to the preſs, to extract the juice thereof, leave that juice to ſettle for a few hours, and ſeparate it afterwards from its coarſer fæces, by decanting it into another veſſel: weigh that juice, and having mixed with it an equal quantity of ſugar, place the mixture over a ſlow fire, to boil gently to the conſiſtence of ſyrup.

Virtues.—This ſyrup ſtrengthens the heart and the ſtomach, reſiſts the malignity of the humours, and hinders abortion.——The *doſe* is from half an ounce to an ounce.

Lohoch.

Lohoch, eclegma and *linctus*, are three words which ſignify the ſame thing, *viz. licking, ſucking*; the firſt is *Arabick*, the ſecond *Greek*, and the third *Latin:* they were given for names to pectoral compoſitions, which have a middle conſiſtence, between ſyrups and ſoft electuaries; the patients are made to ſuck them with a ſtick of liquorice, by dipping one end thereof in them, or with a ſpoon, that being taken by degrees they may remain longer in the paſſage, and humect better the breaſt; they

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are commonly prepared when wanted, becauſe moſt of the remedies which enter their compoſition are ready at all times, and their mixture is not difficult.

For a *pectoral lohoch*. Pound together the roots of enula campana and liquorice, of each a drachm and a half: take ſugar-candy, and oxymel of ſquills, of each half an ounce, and three drachms of the powder diatragacanth; mix all the drugs together with a ſufficient quantity of ſyrup of red poppies, for a *lohoch*.

Virtues. This *lohoch* is uſed in the pleuriſy, aſthma, phthiſick, and other maladies of the breaſt and lungs; it incites and attenuates the phlegm, and excites expectoration.

A *lohoch to ſtop the ſpitting of blood*. Take three drachms of the powder diatragacanth, red roſes, crab's eyes prepared, and prepared coral, of each two drachms, a drachm and a half of conſolida major in powder, fifteen grains of ſalt of ſaturn, four grains of laudanum, the mucilages of the ſeeds of quinces and of pſyllium, of each half an ounce; mix the drugs together in a ſufficient quantity of ſyrup of St. John's-wort.

The roſes and the roots of conſolida major muſt be pounded together, and be mixed with the reſt of the powders: the laudanum muſt be diſſolved in a mortar with about half an ounce of the ſyrup; and then all the other drugs are added to it, to make a *lohoch*, with a ſufficient quantity of the ſame ſyrup.

Virtues. This *lohoch* is proper, not only to ſtop the ſpitting of blood, but likewiſe all other hæmorrhages. It is taken at the end of a ſtick of liquorice.

For a *ſimple lohoch of ſquill*. Take equal parts of the juice of ſquills, and of ſkimmed honey, and boil them together in a glazed earthen diſh, over a ſlow fire to a due conſiſtence.

Virtues. This *lohoch* is proper to rarefy or attenuate the phlegm, and excite expectoration; it helps reſpiration, and is uſed in the aſthma and peripneumony.

POWDERS.

It is neceſſary to reduce into *powder* the dry ingredients which enter the compoſitions of *Medicine*; not only that they may be eaſier and more exactly mixed in them, but that they may likewiſe communicate better their virtue when they are in the body.

Powders are uſually made in braſs mortars; but when they muſt be very fine, they are uſually ground on the porphyry, to render them impalpable: tho' this laſt preparation is ſeldom for any thing elſe but minerals, ſtones and earths.

When *gums* are to be reduced into *powder*, it is neceſſary to anoint the bottom of the mortar, and the end of the peſtle, with ſome drops of oil of ſweet almonds, or other oil, otherwiſe the gums would ſtick to the mortar, and would be pounded but with great difficulty, except notwithſtanding the following:—When the gums arabick and tragacanth are to be pounded, the mortar muſt be heated before with lighted coals, that the heat may diſſipate a ſuperfluous humidity which is in the gums, and would hinder the pulveriſation.——To pound the maſtich, the bottom of the mortar, and the end of the peſtle, muſt be moiſtened firſt with a little water, otherwiſe it would ſtick to the mortar.—When dry aromatick matters, as the cinnamon and ſanders, are to be reduced into powder, they muſt be moiſten'd with ſome water appropriated to their virtue, to hinder the diſſipation, which otherwiſe, would happen of their moſt ſubtile particles.—To pound the coloquintida, it muſt have been anointed before with oil of roſes, otherwiſe much of its particles would eſcape.—When the euphorbium, the cantharides, and the white hellebore are to be pounded, they muſt be humected with ſome drops of vinegar, or other appropriated liquor; for, without that precaution the artiſt would be much incommoded by the volatile particles of thoſe matters, which being agitated by the peſtle, fly and enter the noſe and the eyes, which excites a violent ſneezing and tears. When the ſaffron, roſes, and ſeveral other flowers which preſerve always ſome humidity, though they appear dry, are to be reduced into powder, they muſt be dried gently between two papers in the ſun, or before the fire, otherwiſe it would be very difficult to pound them. The opium, acacia, hypociſtis, liquorice juice, galbanum, opoponax, ſagapenum, and aſafætida, when by themſelves, are not eaſily reduced into powder; but when mixed with dry ingredients of another nature, and in great quantity, they are eaſily conquered: the ſame may be ſaid of the almonds, cold ſeeds, ſmall nuts, *&c*. When flints and other ſuch hard ſtones are to be pounded, they muſt have been made red-hot ſeveral times before, and extinguiſhed in water to ſoften them, otherwiſe it would be very difficult to reduce them into powder. When the talc of *Venice* is to be pounded, it muſt be expoſed for about half a quarter of an hour to a great flaming fire, then pounded in an iron mortar almoſt made red-hot. To pound horns, agarick, and nux vomica, they muſt be raſped before, and afterwards pounded in a mortar of metal. To pound lead and tin, they muſt be put in fuſion in an earthen diſh, then by ſtirring them continually over the fire, for the ſpace of half an hour or an hour, they'll reduce themſelves into powder. Several of the matters to be reduced into powder are to be beaten hard, as wood, roots, leaves,

ſeeds, fruits, horns, and bones; but ſeveral others are only to be bruiſed in the mortar, as the aloes, ſcammony, earths, and ſtarch. Salts, and other acrimonious and corroſive matters, are to be pounded in mortars of glaſs, marble, or of ſtone, to avoid the impreſſion they could receive from the metal.

For the *preparation of the worm-powder of the Phyſicians of the faculty of* Paris.—Take the ſeeds of common wormwood, of porcelain, and aloes, of each half an ounce; the beſt rhubarb, ſenna, coralline, dried ſummits of ſcordium, of each two drachms: the drugs being all pounded, ſhall be mixed together for a powder to be kept for uſe.

Virtues.——This powder kills and expels the worms, provokes the menſes, and reſiſts the malignity of the humours. The *doſe* is from half a ſcruple to a drachm.

The purgatives of this preparation, are the aloes, ſenna, and rhubarb.

The powders where the preparations of mercury enter, ought not to be taken without being formed into a bolus, leſt the mercury which is heavy, ſhould remain behind in the teeth and ſhake them.

For the *preparation of an excellent powder for the dyſenteria*—Take two ounces of the root *ipecacuanhe*; citrin mirabolans, and rhubarb, of each three drachms; and an ounce of ſeed of plantain: pound all thoſe drugs together in a braſs mortar, for a powder to be kept for uſe.

Virtues.—This powder excites vomiting without violence, it purges by ſtools, and ſtops the dyſenteria.——The *doſe* is from a ſcruple to four.

For a *preparation of a powder for the phthiſick.*—Take half an ounce of the ſeed of white poppies; gums arabick and tragacanth, the ſeeds of althæa, of cotton, of porcelain, the four great cold ſeeds, of each a drachm and a half; the aſhes of crawfiſh, and the lungs of a fox, prepared, of each four ſcruples: the gums arabick and tragacanth muſt be pounded together in a mortar heated; the crawfiſh muſt be burnt in a pot made red hot, till they be reduced to aſhes; the ſeeds muſt alſo be pounded a-part till they be reduced into a paſte; and all the drugs muſt afterwards be mixed together for a powder, to be kept for uſe.

Virtues.—This powder is not only good for the phthiſick, but for all the maladies of the breaſt; it abſorbs and ſoftens the acrimony of the ſeroſities which fall from the brain, thickens them, and helps expectoration.—The *doſe* is from a ſcruple to a drachm.

For the *preparation of the gaſcoyn powder*, otherwiſe called *the powder of the Counteſs of* Kent.—— Take four ounces of the black ends of the claws of crabs; crab's eyes, oriental pearls, and red coral prepared, of each an ounce; white ſuccin, the root of contrayerva, and of viperina, of each ſix drachms: two drachms of the ſtone of oriental bezoard; four ſcruples of the bone of a ſtag's heart; and two ſcruples of ſaffron: take out the fleſh of the crab's claws; then bruiſe them with the crab's eyes, the bone of the ſtag's heart, and the bezoard in a mortar; grind them afterwards on the porphyry, till they be reduced into an impalpable powder; let the roots be likewiſe pounded together; and the ſaffron by itſelf, after it has been dried between two papers, at a ſlow heat: mix all thoſe powders together with the pearls and prepared coral, and moiſten them with an ounce and a half of ſpirit of honey; mixing them afterwards with jelly of vipers, to be formed in troches, which muſt be dried from the ſun, and kept for uſe.

Virtues.—This powder is much eſteemed to reſiſt the malignity of humours, for the ſcurvy, the ſmall pox, and other epidemical maladies.—The *doſe* is from half a ſcruple, to half a drachm.

For the *preparation of a powder to facilitate or haſten a delivery*—Take cinnamon, dictamnum of *Crete*, ſaffron, borax, troches of myrrh, of each a drachm; and half a drachm of ſavern: let the cinnamon, dictamnum, and ſavern, be pounded together; and the troches and borax together; then mix all the ingredients for a powder to be kept for uſe.

Virtues.—It is proper to haſten the delivery, when the woman is in labour; and to expel the after-birth.—The *doſe* is from a ſcruple to two: it is alſo uſed to provoke the menſes; diſſolved in white wine, or water of mugwort.

For the *preparation of a powder for the after-pains.*—Take the roots of conſolida major dried, acorn and ſuccin, of each a drachm and a half; dried orange-peel, mace, ſaffron, coriander-ſeed, of each two ſcruples: let all the drugs be pounded together into a fine powder to be kept for uſe.

Virtues.—This powder is proper to appeaſe the after pains, and for the windy cholick.—The *doſe* is from a ſcruple to two.

For the *preparation of a powder for the piles*, or *hemorrhoides.*—Take an ounce of the beſt wheat-flour, half an ounce of crocus martis; oriental bole prepared, the root of verbaſcum, of each two drachms; white hermodacts infuſed for a whole night in ſpirit of wine, and dried again afterwards, dried flowers of red poppies, white ſugar-candy, ſanguis draconis, olibanum, of each a drachm and a half: let all theſe drugs, after they have been pounded according to our method, be mixed together for a powder to be kept for uſe.

Virtues.—This powder ſtops the immoderate flux of the hæmorrhoides, and reſolves thoſe which are tumified, when applied upon them: it is mixed with

with the white of an egg, and the paſte it forms ſpread on flax.

For the *preparation of the powder of verbaſcum for the ſame diſtemper.*—Fill a crucible with green leaves of verbaſcum, cover it with another crucible, lute the joints, and place the veſſel in the middle of lighted coals, to reduce the matter to a ſort of coal, which may be eaſily reduced into powder; take off the crucible, and having pounded the matter, mix with an ounce thereof two drachms of the beſt rhubarb.

Virtues.——This powder is proper to reſolve the hemorrhoides, when applied on them, diſſolved in a little ſaliva, or ſpittle.

For the *preparation of a powder to cleanſe the hands.*——Take the paſte of bitter and ſweet almonds, after the oil has been extracted from it, and flour of rice, of each ſix ounces; iris of *Florence*, and prepared chalk, of each an ounce; benzoin, ſperma ceti, ſalt of tartar, of each two drachms; and half an ounce of the wood of *Rhodium*; pounded and mixed together, for a powder to be kept in a pot, becauſe it is a little of the conſiſtence of a paſte.

Virtues.——This *powder* cleanſes the ſkin, renders it ſoft, white and ſmooth: it is uſed to cleanſe the hands; it may be humected in the hand with ſome water of orange-flowers, inſtead of common water; and rub the hands with it, without humecting it any more, till the paſte dries and falls off of itſelf; then the hands are wiped with a linen cloth, wetted with ſome water of orange-flowers.

TROCHES.

Trochiſcus is a *Greek* word which ſignifies *rotule.* It is alſo called *placentula*, or *orbis*, or *orbiculus*, or *parvus panis*, or *paſtillus*; this laſt name being appropriated to a ſort of troches, which are thrown into the fire, to give an agreeable ſmell to a room, and correct the malignity of the air.—The *Arabs* have called *fief*, the *troches* uſed for the maladies of the eyes.—*Troches*, in general, are dried compoſitions, compoſed of ſeveral medicaments reduced into powder, and incorporated with wine, or ſome diſtilled water, or with juices, or with mucilages, or with pulps, or with ſyrups, in a pretty ſolid conſiſtence. The maſs is well pounded in a mortar, that all the ingredients may be well incorporated together, and is divided into little bits, to which one may give what figure one pleaſes, ſometimes long, ſometimes ſquare, ſometimes triangular, ſometimes round and flat, and ſometimes in ſmall grains; and they are dried afterwards, that they may be kept without growing ſoft.

For the *preparation of the troches of rhubarb.*—Take ten drachms of the beſt rhubarb, half an ounce of bitter almonds, three drachms of red roſes, ſpikenard, anniſeed, wormwood, aſarum, of each a drachm: pound together the rhubarb, roſes, ſeeds, wormwood and aſarum; pound in a marble mortar the bitter almonds, blanched, till they be reduced into a paſte; mix the powders with it, and with a ſufficient quantity of juice of agrimony thicken'd over the fire to the conſiſtence of honey, make a maſs ſolid enough to be formed into little troches, which muſt be put to dry from the ſun.

Virtues.——Theſe *troches* are uſed for the obſtructions of the liver, myſentery, and ſpleen, and for the looſeneſs. They purge gently in binding. ——The *doſe* is from a ſcruple to four.

For the *preparation of troches of camphire.*——Take a drachm of camphire, myrrh, aſafætida, caſtoreum, of each half an ounce; three drachms of ſpikenard; a drachm of ſaffron, half a ſcruple of opium; and eight drops of the oil of ſuccin; when all the drugs which are to be reduced into powder have been pounded, let all the ingredients be mixed in a ſufficient quantity of the mucilage of gum tragacanth, extracted in water of matricaria, for a maſs, of which are formed *troches.*

Virtues.—Theſe *troches* are ſometimes preſcribed in violent fevers, to temperate the heat of the bile and of the blood; for the pleuriſy, and hectick fevers: but their more frequent uſe is for the vapours and the hyſtericks.——The *doſe* is from a ſcruple to two: they are alſo mixed in clyſters from half a drachm to two drachms.

From the *preparation of troches of myrrh.*——Take the beſt myrrh, lupins pared, of each five drachms; dried leaves of rue, dictamnum of *Crete*, cummin-ſeed, aſafætida, ſagapenum, opoponax, of each two drachms: after all theſe drugs have been pounded together, according to our method, reduce them into a hard maſs with the juice of mugwort, or of rue, boiled to the thickeneſs of a mucilage; whereof you'll form *troches.*

Virtues.——Theſe *troches* provoke the menſes, help the delivery, expel the after-birth, and abate the vapours.——The *doſe* is from a ſcruple to a drachm.

Troches for a Gonorrhœa.—Take two drachms of bol ammoniack, prepared ſuccin, and the raſpings of ivory, of each a drachm and a half; four ſcruples of plantain ſeed; agnus caſtus lattuces, flowers of pomegranate, red roſes, of each a drachm; and two ſcruples of ſaſſafras, pounded according to our method, and mixed together in a mucilage of the ſeed of quinces, prepared in water of nenuphar, to form a maſs for *troches.*

Virtues.—Theſe *troches* are proper to dry the ſmall ulcers of the urethra, to ſtrengthen the ſpermatick

matick veſſels, and to ſtop the gonorrhœa.—The *doſe* is from a ſcruple to a drachm.

Troches for the Aſthma.—Take nine ounces of white ſugar-candy; an ounce and a half of ſtarch, iris of *Florence*, and magiſterium of ſulphur, of each half an ounce; three drachms of liquorice, and two ſcruples of flowers of benjoin, pounded according to our method, and mixed in a mucilage of gum tragacanth extracted in roſe water, to form a hard maſs for troches.

Virtues.—Theſe troches are excellent for the aſthma, for an inveterate cough, to help reſpiration, and expectoration.—The *doſe* is from half a drachm to a drachm.

Anodyne troches.—Take half an ounce of laudanum, caſtoreum, myrrh, and ſaffron, of each two drachms; and a ſcruple of camphire, pounded according to our method, and mixed in a mucilage of gum tragacanth, extracted in the juice of henbane, for *troches*.

Virtues.—Theſe *troches* are proper to appeaſe pains in whatever parts of the body they be, to abate the vapours, to promote ſleep and ſweat.—The *doſe* is from four grains to half a ſcruple.

Troches to ſtop the vomiting of blood.—Take red roſes, the ſeeds of henbane, flowers of pomegranate, oriental bol, acacia, gum arabick, opium, an equal quantity of each, pounded or prepared according to our method, and mixed in a mucilage of gum tragacanth extracted in water of porcelain, to form a maſs for *troches*.

Virtues.—Theſe *troches* are proper to ſtop all ſorts of hæmorrhages, and to appeaſe exceſſive pains.—The *doſe* is from eight grains to a ſcruple.

Troches to ſtop the immoderate flux of the piles.—Take ten drachms of bdellium, five drachms of myrabolans, three drachms of the ſeeds of leek, prepared coral, prepared ſuccin, prepared bol ammoniack, calcined ſhells, of each two drachms; pounded according to our method, and reduced into a hard maſs, with a mucilage of gum tragacanth, extracted in roſe-water, for *troches*.

Virtues.—They are aſtringent, and may be uſed to ſtop a looſeneſs, and all ſorts of hæmorrhages.—The *doſe* is from half a drachm to two drachms.

Troches for a Diarrhœa.—Take the ſeeds of ſorrel, barberries, myrtles, cheſnuts, amydon or ſtarch, and ſpodium, of each five drachms; ſuccin and coral, of each three drachms; pounded according to our method, and mixed with a mucilage of gum tragacanth, prepared in roſe-water, to form a maſs for *troches*.

Virtues.—They are proper to ſtop a looſeneſs, and hæmorrhages.—The *doſe* is from half a drachm to two drachms.

Troches for the Diabetes.—Take the berries of the myrtle-tree and the ſeed of ſorrel, of each two ounces; gum arabick and ſtarch, of each an ounce, pounded; and mixed with a mucilage of ſeed of pſyllium, for *troches*.

Virtues.—They ſtop the immoderate flux of the urine, by ſtrengthening the conduits of the bladder, and are alſo good for ſpitting of blood.—The *doſe* is from a ſcruple to a drachm.

PILLS, PILULA, is a diminutive of *pila*, *quaſi parva pila*, becauſe *pills* are formed in little balls. The *Greeks* called them *catapotia*, from the verb καταπινω, *devoro*, becauſe they are ſwallowed without chewing.

PILLS, have been invented for two principal reaſons. 1. That in that form ſeveral remedies may be taken eaſily, which would be very inſupportable to the taſte, if taken in another manner, as the aloes, coloquintida, agarick, turpentine, &c. or would ſtick to the teeth, and perhaps ſhake them, as the mercurius dulcis, and all other mercurial preparations; and there are even ſo many patients ſo very nice, that they would not take any remedy ever ſo little diſagreeable, if they were not reduced into pills.—2. That the remedy being taken dry, may remain longer in the viſcera, and have more time to communicate its virtues to the diſtant parts, as to the head and joints. Moſt *pills* are *purgative*; but there are alſo ſome *alterative*, *aſtringent*, *ſomniferous*, *diaphoretick*, *aperitive*, *hyſterick*, *cephalick*, *bechick*, *arthritick*. *Pills* are otherwiſe preſerved than *troches*; for inſtead that the *troches* are made as ſoon as the maſs is made, that they may be dried, the maſs of the *pills* is kept, that the drugs it is compoſed of may ferment together; and therefore are only formed as they are wanted. But it muſt be obſerved, that when the maſs of *pills* has been made with juices or other liquors, without ſugar or honey, it grows ſo hard ſoon afterwards, that it muſt be reduced into powder, and mixed anew with a liquor to form *pills* thereof; which happens becauſe the liquors corporify, and dry without growing moiſt again; whereas when ſyrup or honey has been uſed, the maſs cannot dry ſo much, becauſe the honey and ſyrup contain a great deal of ſalt, which take eaſily the humidity of the air, which keeps that compoſition in the conſiſtence it muſt have.——It is much more advantageous that the maſs of *pills* ſhould remain ſoft, than too hard, becauſe the fermentation is much better made in the humidity than in dryneſs. As *pills* could communicate a bad taſte in paſſing through the palate; they are wrapped in wafers, or in gold or ſilver leaves, or in powder of liquorice, &c.

Pilulæ cocciæ majores.——Take ſix drachms of jalap

jalap, half an ounce of troches of alhandal, three drachms of ſcammony, two drachms of ſoluble tartar, and a drachm of aloes; reduce all theſe drugs into powder, and form a maſs of them with a ſufficient quantity of ſyrup of ſtechas, or juice of wormwood, for *pills*.

Virtues.—Theſe pills purge all humours, but particularly the pituita; therefore they are preſcribed to purge the brain.—The *doſe* is from a ſcruple to a drachm.

Pilulæ cocciæ minores, ſeu mirabiles.—Take aloes ſuccotrina, the beſt ſcammony, troches of alhandal, equal parts of each: let the ſcammony and aloes be pounded together into a very ſubtile powder, in a mortar anointed with ſome drops of oil, reducing alſo into powder the troches of alhandal; and mixing afterwards all the ingredients together with ſyrup of roſes compoſed with agarick, to form a maſs for *pills*.

Virtues.—Theſe *pills* are proper to purge all humours, but they are chiefly uſed to purge the brain.—The *doſe* is from half a ſcruple to two ſcruples.

Catholick Pills.—Take two ounces of aloes ſuccotrina; an ounce and a half of the beſt rhubarb; troches of agarick and ſenna, of each an ounce; and half an ounce of ſoluble tartar; pounded according to our method, and mixed with ſyrup of violets, or of roſes, into a maſs for *pills*.

Virtues.—Theſe *pills* purge all humours, ſtrengthen the ſtomach and brain, and raiſe the obſtructions.—The *doſe* is from a ſcruple to a drachm.

Pills for the Dropſy.—Take two ounces and a half of aloes ſuccotrina; an ounce and a half of gum gut, reduced into a ſubtle powder, and diſſolved in wine of malmſey; an ounce of diacrydium prepared in the ſame manner; an ounce and a half of the beſt gum ammoniack; and half an ounce of vitriolated tartar; pounded and mixed together in ſolutive ſyrup of roſes to make a maſs for *pills*.

Virtues.—Theſe *pills* are proper to raiſe the obſtructions of the ſpleen, and meſentery; for the hydropſy: they purge powerfully.—The *doſe* is from half a ſcruple to a ſcruple.

The purgative drugs of this compoſition, are the aloes, gum gut, and diacrydium.—A ſcruple of theſe pills, contains ſeven grains of aloes, four grains of gum gut, and about three grains of diacrydium. Half a drachm contains ten grains and a half of aloes, ſix grains of gum-gut, and about four grains and a half of diacrydium. Two ſcruples contain fourteen grains of aloes, eight grains of gum-gut, and about ſix grains of diacrydium.

The preparation given here to the gum gut, and to the diacrydium, by humecting them with wine, to grind them on the porphyry, ſeems to me needleſs; ſince it ſuffices to reduce thoſe gums into a very ſubtle powder, to mix them exactly with the other drugs.

Hyſterick Pills.—Take ten drachms of extract of aloes, prepared with the juice of mugwort, myrrh, vitriol of *mars*, and ſalt of mugwort, of each two drachms; caſtoreum, camphire, and leaves of rue, of each two ſcruples; pounded according to our method; and mixed together with juice of mugwort for *pills*.

Virtues.—They purge and abate the vapours, cleanſe the matrice of its impurities, by unſtopping the obſtructions, and provoke the menſes.——The *doſe* is from a ſcruple to a drachm and a half.

There is properly nothing here but the extract of aloes, which can be called purgative; the other drugs helping only the aloes to rarefy the blood, and raiſe the obſtructions.

Arthritick Pills.—Take two ounces and a half of aloes ſuccotrina; half an ounce of ſcammony; hermodacts, turbith, agarick, troches of alhandal, mercurius dulcis, and ſoluble tartar, of each two drachms; pounded according to our method; and reduced into a maſs for *pills*, with the ſyrup of roſes.

Virtues.—Theſe *pills* are thought proper particularly to purge the joints; they are preſcribed for the gout and rheumatiſm.——The *doſe* is from half a ſcruple to two ſcruples.

The reaſon why the *arthritick pills* purge the joints, is, becauſe being compoſed of dry remedies, and full of volatile parts, they remain a long while in the *viſcera*, and have time to ſpread their ſubſtance on all ſides.

Mercurial Pills.—Take quick-ſilver, and aloes ſuccotrina, of each ſix drachms; half a drachm of troches of agarick; and two drachms of the beſt rhubarb; let the quick-ſilver be extinguiſhed in a ſufficient quantity of turpentine of *Venice*; and mix afterwards the powders with it, to form a maſs for *pills*.

Virtues.—Theſe pills purge the bilious humours, and the ſeroſities; they are preſcribed in the venereal diſeaſe, for the ſciatica, the itch, leproſy, the obſtructions, and the king's-evil.—The *doſe* is from a ſcruple to a drachm.

Pilulæ de duobus.—Take equal parts of troches of alhandal, and of ſcammony, pounded, and reduced into a maſs for pills, with the ſolutive ſyrup of roſes.

Virtues.—Theſe pills purge the coarſe pituita, and the ſeroſities, and diſengage the brain. They

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are preſcribed for the gout and the hydropſy.——The *doſe* is from eight grains to a ſcruple.

Cephalick Pills.—Take of the maſs of *pilulæ cocciæ*, and ſcammony, of each ſix drachms; black hellebore, and vitriolated tartar, of each three drachms; prepared according to our method, and reduced into a maſs with ſyrup of roſes compoſed with agarick.

Virtues.—Theſe pills purge and ſtrengthen the brain; are proper for the hypochondriacks, the mania, epilepſy, and vertigo.——The *doſe* is from half a ſcruple to half a drachm.

Pilulæ de opoponacis. Meſué. ℞. *aloes ſuccotrina*, ℥ j. ſs. *trochiſcorum alhandal, hermodactylorum, opoponacis, ſagapeni, bdellii, ammoniaci, ā* ʒ v. *myrabolanorum emblicorum, citrinorum, bellericorum, caſſiæ lignææ, piperis nigri, zingiberis, croci, piperis longi, myrrhæ, caſtorei, ā* ʒ j. *cum ſucco caulium fiat maſſa, S. A.*

Virtues.—Theſe pills purge all humours; they are principally uſed to purge the brain and the joints; and are preſcribed for the gout, the convulſions, rheumatiſms, and to provoke the menſes.——The *doſe* is from a ſcruple to a drachm.

The purgative ingredients which enter this compoſition are the aloes, the troches of alhandal, the hermodacts, the turbith, the diacrydium, and the myrabolans.

Several drugs, which are pretty needleſs, could be retrenched for this compoſition, the ſagapenum, bdellium, ammoniack, caſſia lignea, the papers, ginger, ſaffron and myrrh. I find that the quantity of the opoponax, from which the pills borrow their name, ſhould be increaſed, and that inſtead of the needleſs drugs, ſome grains of ſoluble tartar ſhould be introduced into them. Therefore I'm of opinion, that thoſe pills ſhould be compoſed in the following manner.

Pilulæ opoponacis reformatæ. ℞. *gummi opoponacis*, ℥ jj. *aloes ſuccotrinæ* ℥ j. ſs. *trochiſcorum alhandal, hermodactylorum, āa* ʒ v. *turbith*, ʒ ſs. *myrabolanorum citrinorum mundatorum, tartari ſolubilis, āa* ʒ jjj. *diacrydii*, ʒ jj. *caſtorei*, ʒ j. *cum S. q. Syrupi de pomes regis ſaporis, fiat maſſa pilul. doſis erit a* ℈ ſs. *uſque ad* ʒ j.

Pills for a quartan ague.—Take an ounce of aloes ſuccotrina; diacrydium, agarick, ſoluble tartar, of each two drachms; aſarum and black hellebore, of each a ſcruple; prepared according to our method, and reduced into a maſs, with a ſufficient quantity of ſyrup of pale roſes.

Virtues.——They purge the pituita, and melancholy; they are uſed in intermittent fevers, and particularly in the *quartan ague.*——The *doſe* is from one ſcruple to two ſcruples.

The *quartan ague* being moſt commonly cauſed and entertained by the coarſe and tartarous humours, which ſtop ſeveral ſmall veſſels of the ſpleen, of the pancreas, or of the other viſcera; it is neceſſary to preſcribe for that malady, ſtrong and penetrating remedies, ſuch as thoſe which enter theſe pills, to rarefy thoſe humours, and raiſe the obſtructions.

Pills for the iliack paſſion, or *miſerere.*——Take troches of alhandal, and ſagapenum, of each ſix drachms, and two drachms of diacrydium; prepared according to our method, and reduced into a maſs, with a ſufficient quantity of juice of leeks.

Virtues.——They are proper for the iliack paſſion, for the cholick, the migram, and purge the pituitous, and other humours.

Pills for the Cough.——Take the juice of liquorice, and olibanum, of each half an ounce; myrrh, ſaffron, and opium, of each four ſcruples; prepar'd and pounded according to our method, and mixed with a ſufficient quantity of ſyrup of poppies rhœados to form a maſs for pills.

Virtues.——Theſe pills agglutinate and thicken the acrimonious humour, which fall from the brain on the breaſt; they appeaſe the cough, and provoke expectoration and ſleep.——The *doſe* is from ſix grains to a ſcruple.

Half a ſcruple of theſe pills for the cough contains a grain of opium. *Eighteen grains* contain a grain and a half of opium. A *ſcruple* two grains of opium. And *half a drachm*, three grains of opium.

Pilulæ ad gonorrhœam virulentam. ℞. *Antimonii diaphoretici, cinnabaris nativæ & antimonialis, terræ ſigillatæ, radicis ireos florentiæ, liquiritiæ. Succini albi præparati, oculorum cancror, præparatorum, āa* ℥ ſs. *myrrhæ electæ, olibani, maſtiches, croci, āa* ʒ ij. *cum terebenthina veneta, fiat maſſa pilularum.*

Virtues.—Theſe *pills* are aſtringent, and ſtrengthen the ſpermatick veſſels, by correcting the virus.——The *doſe* is from a ſcruple to two.

Pilulæ ſudorificæ. ℞. *Gummi guiaci* ℥ j. *extracta contrayervæ* ʒ vj. *myrrhæ* ʒ v. ℈ j. *croci* ℥ ſs. *camphoræ* ʒ ij. ℈ ij. *laudani opiati* ℈ ij. *miſce, & cum ſyrupo de floribus tunicæ, fiat maſſa pilularum.*

Virtues.—Theſe pills reſiſt the malignity of the humours, appeaſethe pains, and promote ſleep and ſweat; they are uſed in malignant fevers.——The *doſe* is from a ſcruple to a drachm.

Tabellæ, or Solid Electuaries. *Tabellæ*, or *lozenges*, or *ſolid electuaries*, have been invented for four principal reaſons.——1. To give a good taſte to the remedies, becauſe more ſugar is mixed in them than in the other compoſitions.——2. That they remain a long while to melt and be diſſolved in the mouth, and their virtue

tue be better communicated to the throat and breaſt.——3. That they may be kept long; for a ſolid conſiſtence is leſs ſubject to corruption than others.——4. To render the compoſition portative. — *Tabellæ* are prepared over the fire, and without fire. Now powders are introduc'd into thoſe made over the fire; but the *doſe* thereof is not ſo much limited: for in the one no more than an ounce of powder enters on each pound of ſugar; on the others, three; and on the others four. The matter of the *tabellæ* which are prepared over the fire is cut in lozenges, or ſquare wiſe, and thoſe prepared without fire are figured into paſtilles or rotulæ.

Tabellæ diaturpethi cum rheo. ℞. *Turbith, rhabarb.* āa ʒ x, *hermodactylorum* ℥ j, *diacrydii* ℥ ſs. *ſeminis violarum* ʒ ij. *ſacchari albi* j. lb *fiant tabellæ*, S. A.

Virtues.——Theſe *pills* purge the bile and pituita, and are proper for the rheumatiſm, the gout, and the worms.——The *doſe* is from a drachm to an ounce.

The purgative and eſſential ingredients which enter this compoſition are the turbith, rhubarb, hermodacts, diacrydium, and ſeeds of violets, *i. e.* that they are all purgative except the ſugar.

Tabellæ mercuriales. ℞. *Panaceæ mercurialis*, ℥ ij. *cinnamomi acutiſſimi, ireos florentin, zingiberis*, āa ʒj. *ſacchari albi*, ℥iv.

The ginger, cinnamon, and iris, muſt be pounded together; and the ſugar by itſelf; mixing afterwards all the powders with the mercurial panacea in a marble mortar; and corporifying that mixture with a ſufficient quantity of the mucilage of gum tragacanth, beating it a long whiſe with a wooden peſtle, till it be reduced into a ſolid paſte, to form of it ſmall lozenges or rotules, each of them to weigh a drachm.

Virtues.——Theſe tabellæ excite the ſalivation; and are given to thoſe of a hard conſtitution, and that cannot be moved by the common remedies.

Tabellæ pectorales D. gendron abbatis. ℞. *Hordei integri*, j. lb. *uvarum paſſarum mundatarum*, ℥iv. *liquiritiæ raſæ & contuſæ*, ℥ iij. *ſeminis aniſi*, ʒj. *caryophyllos*, No. XIV.

Tabellæ de althæa compoſitæ. ℞. *Pulpæ radicis althææ*, ℥ ij. *Seminis papaveris albi, ireos florentin. liquiritiæ, pulveris diatragacanthi frigidi*, āa ʒ iij. *Sacchari albiſſimi in aqua roſarum cocti*, j. *lb. Fiant tabellæ, S. A.*

The iris, liquorice, and ſeed of poppies, muſt be pounded together, and the powder mixed afterwards, with that of diatragacanthi frigidi; boiling the ſugar afterwards, to the conſiſtence of ſugar of roſes: and mixing in it, when taken off the fire, the pulp, then the powder, to make of it a ſolid paſte; which ſhall be extended on an oily paper and cut into lozenges.

Virtues.——Theſe tabellæ are good for an inveterate cough, for the aſthma, and the ulcers of the lungs: about a drachm of them is put to melt in the mouth.

If two drachms of magiſtery of ſulphur were added to the compoſition of theſe tabellæ, they would be more proper for the ulcers of the lungs, and for the aſthma. Theſe tabellæ can alſo be made without fire, by mixing the powders with pulveriſed ſugar, incorporating the whole mixture in a marble mortar, with a ſufficient quantity of pulp of althæa, to be reduced into a ſolid maſs, whereof paſtilles or rotulæ are formed. Theſe rotulæ can be render'd more deterſive, by adding a ſcruple of flowers of benzoin to the compoſition.

Tabellæ lithonthripticæ fernelii, reformatæ. ℞. *Sanguinis hirci præparati*, ℥j ſs. *Oculorum cancror præparat.* ℥ ſs. *Seminum apii, aſparagi, urticæ, ſaxifragiæ, bruſci, petroſelini, ocimi*, āa ʒ ij. *Radicum cypri, coſti, gummi tragacanthi, chamædryos, ſpicænardi*, āa ʒ j. *Cardamomi, macis, zingiberis* āa ʒ ſs. *Sacchari in aqua parietariæ, cocti*, iij. *lb. Fiant tabellæ, S. A.*

Virtues.——Theſe tabellæ are proper to attenuate the ſtone, the gravel, and the phlegm, and to expel them by urine.——The *doſe* is from a drachm to three.

OPIATES, CONFECTIONS, and ELECTUARIES.

The name of *opiate* was antiently given but to liquid compoſitions, where *opium* was introduced, but at preſent it is given to ſeveral *electuaries* where there is no real *opium*.——The names of *confection*, and of *electuary*, denote very near the ſame thing: the firſt comes from *conficere*, which ſignifies to accompliſh or perfect; and the laſt ſignifies *confectio rerum electarium*; therefore we ſay *electarium*, as well as *electuarium*. Theſe three preparations have conſiſtences very much like that of honey; and are compoſed of powders, pulps, ſugar, honey, and liquors. They are adminiſtered inwardly, and invented by the antients to correct the too violent action of ſome remedies; to excite and increaſe the virtues of ſome others, to unite by mixture and fermentation the qualities of the mixts, that they may form a more perfect compoſitum; that the remedies may be kept longer, to put them in a condition to be eaſier and ſooner taken, without the patient being obliged to wait for the preparation.

Antidotum aſyncitum, Actuarii. ℞ *Opii* ʒ vi. *Myrrhæ* ʒ v. ∋ ij. *Piperis nigri, ſeminis petroſelini* āa ʒ v. *Opii, ſinapeos* āa ℥ ſs. *Schænanthi* ʒ iij. *Amomi, ſtyracis calamit.* āa ʒ ij. *Mag-*

matis hedyctoi ℈ v. *Cassiæ lignæ, piperis albi, seminis sifelios aa* ℈ iv.

The peppers, seeds, amomum, schænantum, and cassia lignea, must be pounded together; and the myrrh, storax, and the troches of hedyctoi, together; the opium must be cut in small pieces, and pounded in a brass mortar with a little honey to reduce it into a paste; mixing that paste with sixteen ounces of skimmed honey, and incorporating the powders in that mixture, to make of them all an opiate, to be kept in a pot well cover'd, for use.

Virtues.——This *opiate* is proper to resist the malignity of the humours, and to appease pains: it is used for the epilepsy, phrenzy, and the tooth-ach; for the contagious maladies, an inveterate cough, and to provoke sleep.——The *dose* is from a scruple to a drachm.

This preparation is an opiate, whereof *Actuarius* is the author. The name *Syncritum* signifies *none-such*, to express its great virtues.——In a *scruple* of this *opiate* there is little less than a grain of opium. In *two scruples*, about a grain and a half; and in *two drachms*, two grains and a half.

Theriaca andromachi. R. *Trochiscorum scilliticorum* lb. ss. *Viperinorum, hedycroi, piperis longi, opii aa* ℥ iij. *Iridis florentin. rosarum rubrarum, succi glycyrrhizæ seminis huniados, scordii, opobalsami, vel succedanei, olei nucis moschatæ, cinnamomi, agarici aa* ℥ j. ss. *Nardi Indici, dictamni cretici, radicis pentaphyllii, zingiberis, costi, rhapontici, prassii albi, stæchadis arabicæ, schænanthi, seminis petroselini macedonici, calaminthæ montanæ, cassiæ lignæ, croci piperis albi & nigri, myrrhæ tragoditicæ, olibani, terebinthinæ chiæ aa* ℥ vj. *Amomi racemosi, radicum gentianæ acori veri, meu athamantici, valerianæ, nardi Celticæ, chamæcistyos, comæ hyperici, seminum ammeos, thalspos, anisi, fœniculi, siseleos massiliensis, cardamomi minoris, malabarthi, comæ polii montani, chamædryos, carpobalsami, succi hypocistidis, acaciæ veræ, gummi arabici, styracis calamitæ, terræ lemnicæ, chalcitidis veri, sagapeni aa* ℥ ss. *Radicis aristolochiæ tenuis, comæ centauris minoris, seminis dauci cretici, opopanacis, galbani puri, bituminis, judaici, castorei, āa* ℥ ij. *Mellis optimi despumati & cocti* xiv. lb. ss. *Vini generosi*, q. s.

All the drugs must be pounded together, except the turpentine and opobalsamum, without the least fear that the gums and juices should prove an obstacle to the pulverization; since on the contrary, they hinder by their glutinosity a too great dissipation of the subtle parts of the mixture.

Put the honey and *Spanish* wine in a large bason over a middling fire, and when the honey shall be dissolved, strain it through a sieve; boil gently the colature to the consistence of a thick syrup; then take the bason off the fire, and mix with the matter, when half cold, the powders by degrees, then the opobalsamum or oil of nutmegs, and the turpentine which must have been liquified together over a slow fire; agitating the mixture for a considerable time with a wooden spatula till it be quite cold. This preparation will be the *theriack* or *andromachus*, which must be kept in a pot well cover'd; taking care to stir it from time to time, to excite the fermentation thereof.

Virtues.——This *opiate* or *antidote* is proper against all sorts of contagious maladies, against the plague, malignant fevers, and the small-pox; the bite of a venomous beast, the poison of hemlock, and of the napelus: it is good for the windy colick, and the worms; for the asthma, the intermittent fevers, the palsy, apoplexy, epilepsy, lethargy, and the hystericks; while new it provokes sleep, because the opium is predominant; and then it is good to stop the hæmorrhages, and the looseness; but when it grows old, it loses that somniferous quality; because the viscous parts of the opium have been rarefied and exhaled by fermentation.

Old *theriacle* is preferable to the new, to resist venom, because its parts are subtilized and exalted by fermentation, and rendered capable to dissolve and rarefy the congelations formed in the blood, or other humours, either by the bites or stings of venomous beasts, or by other coagulating poisons, or by the infected air, or by a too great quantity of acids which may chance to be in the body. Old *theriacle* is also preferable to the new, to strengthen the brain and the stomach, and to provoke perspiration, because in a long fermentation there have been formed several subtle parts, proper to produce that effect.

However, though this composition be much respected in medicine, either for its antiquity, or the effects it has produced; it seems to me, that a more efficacious remedy could be prepared with a small number of the most essential drugs it contains, chosen and mixed together according to the idea of the physician, without being at the trouble and expence of making so large and so embarassing a preparation; for it happens very often that certain drugs which enter the preparation of the *theriacle*, are good for one constitution, and contrary to another; for it is difficult to appropriate for all the maladies, where the *theriacle* is administer'd, so great a number of different drugs heaped upon one another; which do not seem to have been introduced into the composition, by the choice of a learned physician.

Theriaca diatessaron, mesué. ℞. *Radicum gentianæ, aristolochiæ rotundæ, baccharam lauri, myrrhæ electæ,* ℥ ij. *Mellis optimi despumati,* lb. ij. *Fiat ex arte electuarium.*

Virtues.—This *theriacle* is good against the bites of venomous beasts, against the epilepsy, the convulsions, colick, to expel the after-birth, to provoke the menses, and strengthen the stomach.——The *dose* is from a scruple to a drachm.

Diatesseron signifies a composition of four drugs.—This *theriacle* is also called the *treacle of the poor*; because it is made at a little expence, and in a short time.

Electuarium diasulphuris reformatum. ℞. *Magisteris sulphuris,* ℥ j ſs. *Olibani, myrrhæ, styracis calamitæ, radicis helenii, tussilaginis, meu athamantici, liquiritiæ, ireos florentin. seminis anisi, āa* ℥ j. *Gum arabici, caryophyllorum, croci, florum benzoini, āa* ℥ ij. *Conservarum capillorum veneris, & tussilaginis per setaceum trajectarum, āa* ℥ ij. *Mellis in decocto hyssopi, & scabiosæ despumati, & ad consistentiam opiatæ cocti,* iij. lb. *Fiat electuarium, S. A.*

Virtues.—This electuary is proper for the asthma, to soften the acrimony of the breast, to rarefy the coarse pituita; and to abate the vapours, and to appease the pains——The *dose* is from a scruple to a drachm and a half.

Electuarium diascordium fracastorii reformatum, ℞. *Foliorum scordii* ℥ iij. *Rosarum rubrarum exungalatarum,* ℥ j ſs. *Cinnamomi, radicis tormentillæ āa* ℥ vj. *Styracis calamitæ foliorum dictamni cretici, radicis gentianæ, galbani, succini, āa* ℥ ſs. *Opii, piperis longi, zingiberis, seminis oxalidis, āa* ℥ ij. *Mellis rosati in electuarii mollis consistentiam cocti,* iij. lb. *Vini hispanici,* ℥ ij. *Fiat ex arte opiata.*

Virtues.—This electuary is used in malignant fevers, the plague, to kill the worms, to resist putrefaction, for the colick; and provokes sleep when new.——The *dose* is from a scruple to a drachm.

Confectio alkermes reformata. ℞. *Syrupi hermesini optimi recenter parati, & ad mellis consistentiam cocti,* lb. j. ſs. *Santali citrini, & cinnamomi, āa* ℥ j. *Ambræ griseæ,* ʒ j. *Meschi,* ʒ ſs. *Olearum macis & caryophylloreum, āa gutt.* vj. *Fiat confectio, S. A.*

Virtues.—The confection *alkermes* is proper to strengthen the heart, the stomach, and the brain; to resist putrefaction, to raise the spirits, to expel the melancholy, and to provoke the seed. It is prescribed in the palpitations of the heart, and in the syncopes; and it hinders abortion.——The *dose* is from a scruple to a drachm. It is also employ'd in epithem, applied on the region of the heart, and of the stomach.

A *confection against worms.*—Take of semen contra, one ounce, the best rhubarb, and mercurius dulcis, of each half an ounce: pound the semen contra, and the rhubarb together; and the mercurius dulcis by itself; mix the powders, and incorporate them in half a pint of syrup of juice of porcelain, boiled to the consistence of a soft electuary, for an opiate, which is to be kept in a glass or stone vessel.

Virtues.—This opiate is proper to kill the worms, and evacuate them gently; and to hinder their generation.——The *dose* is from a scruple to two drachms.

Electuarium sassafras reformatum. ℞. *Ligni sassafras odorantissimi,* ℥ ij. *Cinnamomi,* ʒ iij. *Ambræ griseæ,* ʒ ſs. *Macis,* ℈ j. *Moschi gr.* iij. *Sacchari albi in aqua fœniculi dissoluti & cocti,* lb. j. ſs. *Fiat electuarium, S. A.*

Virtues.—This electuary is proper to resist the malignity of the humours; it is sudorifick; it strengthens the brain, the stomach, and the heart, sharpens the sight, and helps the digestion.—The *dose* is from half a drachm to two drachms.

Electuarium pectorale. ℞. *Pinearum,* ʒ j. *Succi glycyrrhizæ, amygdalarum dulcium, avellanarum, āa* ℥ ſs. *Hyssopi, capillorum veneris, seminis urticæ, radicis ireos, & aristolochiæ rotundæ, āa* ʒ j ſs. *Enulæ campanæ, piperis nigri, seminis nasturtii, āa* ʒ ſs. *Mellis despumati,* lb. j, ℥ ij. *fiat electuarium, S. A.*

Virtues.—This *electuary* is proper to provoke expectoration, to loosen the phlegms fastened to the lungs, to the breast, and to the diaphragm, and to help respiration.—The *dose* is from a scruple to a drachm.

Electuarium scorbuticum. ℞. *Conservarum cochleariæ,* ℥ ij. ſs. *Chamædryos, melissæ, rosarum pallidarum, citri, āa* ʒ vj. *Cinnamomi, cardamomi, āa* ℥ j. *Conditorum calami aromatici, zingiberis, radicis pimpinellæ, corticis citri, aa* ʒ iij. *Extractorum absinthij & juniperi, seminis sinapi & erucæ, aa* ʒ ij. *Tartari vitriolati,* ʒ j. ſs. *Oleorum cinnamomi,* ʒ ſs. *Anisi,* ℈ j. *cum spiritu de cinnamomo & de cochlearia, q. ſ.*

The cinnamon, cardamum, and the seeds, must be well pounded together; and the powders mixed with the vitriolated tartar, beat in a marble mortar, the lemon peel, and the confect roots, and the conserves, till they be reduced into a paste, humecting them with some syrup of lemons, straining them afterwards into a pulp through a sieve of horse hair; and mixing in that pulp the extracts, the powders, the oils, and a sufficient quantity of the spirits of cochlearia, and cinnamon, to make an electuary, which must be kept in a pot well stopped.

The extracts of juniper-berries, and of worm-

wood, cannot be made without letting eſcape the moſt volatile parts, in which their principal virtue conſiſted. Therefore it would be better to employ here the juniper-berries, and ſummits of wormwood pounded only.

Electuarium terebinthinatum. ℞ *Terebinthinæ claræ* lb j. *Radicis biſmalvæ, graminis, ononidis, bruſci, liquiritiæ āa* ℥ j. *Gummi arabici, & tragacanthi oculorum cancri præparatorum, nitri purificati, ſalis ſulphuris, millepedum præparatorum āa* ʒiij. *Salis volatilis ſuccini, aquilæ albæ āa* ʒij.

The roots and millepedes muſt be pounded together, the gums in a warm mortar; the ſalts by themſelves, and the mercurius dulcis by itſelf; then the powders muſt be mixed with the crab's eyes prepared; and the whole incorporated with the turpentine to make an electuary, which muſt be kept for uſe.

Virtues.—This *electuary* is proper to attenuate the ſtone in the reins and the bladder; to expel the ſand and phlegms by urine, for the nephritick; to cleanſe and conſolidate the ulcers of the reins, and of the bladder, and of the matrice; for the virulent gonorrhœa's, and all retentions of urine. —The *doſe* is from a drachm to a drachm and a half in a bolus.

Electuarium lenitivum pharmacopœæ pariſienſis. ℞ *Hordei excorticati, radicis polypodii quercini contuſæ, paſſularum enucleatarum, tamarindorum aa* ℥ ij. *Jujubas, pruna, ſebeſten aa,* xx. *Seminis violarum, liquiritiæ raſæ & contuſæ aa* ℥ j. *Foliorum mercurialis, man.* ij. *Adianti man.* j.

Make a decoction thereof in twelve pints of common water, till they be reduced to ſeven; then add towards the end *foliorum orientalium mundatorum* ℥ ij. *ſeminis fœniculi dulcis* ℥ ij. to four pints of the colature add three pounds of the beſt ſugar; letting the whole mixture boil to the conſiſtence of ſyrup; in which muſt be diſſolved the pulps of of prunes boiled in one part of the decoction left; of tamarinds, and of caſſia ſtrained with the reſt of the decoction, of each half a pound; five ounces of ſenna in powder, and two drachms and a half of aniſeed, for an electuary.

Virtues.——This *electuary* ſoftens the humours, and purges particularly the bile, without violence. —The *doſe* is from half an ounce to an ounce and a half.

Lenitivum aliud excellentiſſimum. ℞ *Decocti radicis althææ, & ficuum pinguium* lb iv. *Sacchari albi* lb iij. *Coquantur ad conſiſtentiam mellis, tunc miſce pulpæ caſſiæ recenter extractæ* lb j. *Pulpæ prunorum, pulveris ſenæ aa* lb ſs. *Seminis violarum* ℥ iij. *Tartari ſolubilis* ℥ i. ſs. *Fiat electuarium,* S. A.

Electuarium aperiens A. daquin. ℞ *Foliorum ſennæ orientalis mundatorum* ℥ vi. *Diacrydii, trochiſcorum alhandal, agarici electi, rhabarbari, & ſeminis violarum āa* ℥ j. ſs *Sagapeni, myrrhæ, gummi ammoniaci, a a* ℥ j. *Antimonii diaphoretici, mercurii dulcis, aa* ʒ vi. *Salis martis, & tamariſci aa* ℥ ſs.

The ſenna, troches of alhandel, agarick, rhubarb, ſeed of violets, and ſagapenum muſt be reduced together into a ſubtile powder, the gum ammoniack, the myrrh, and the diacrydium pounded together; and the mercurius dulcis and diaphoretick antimony together; then all thoſe powders muſt be mixed with the ſalts; and all together with ſix pounds of ſkimmed honey, to make an electuary, which muſt be kept for uſe.

Virtues.——This *electuary* purges all humours, rarefies the viſcous and coarſe matters, raiſes the obſtructions, and provokes the menſes. It is preſcribed in quartan agues, cachexies, hypochondriacal maladies, and hydropſy.——The *doſe* is from one drachm to ſix.

This compoſition is a mixture of eſſential remedies.

Hiera picra ſimplex Galeni. ℞ *Aloes ſuccotrinæ* ℥ vi. ʒ ij. *Cinnamomi, xylobalſami, vel bujus loco ſurculorum lentiſci, aſari, ſpicæ indicæ, croci, maſtiches ana* ʒ iij. *Mellis deſpumati* lb ij. ℥ i ſs. *Fiat electuarium,* S. A.

The cinnamon, xylobalſam, or in its ſtead the lentiſewood, the aſarum, and the ſpikenard, muſt be pounded together, the aloes and maſtich together; and the ſaffron, after it has been dried between two papers by itſelf; the ingredients thus pounded muſt be mixed together, and the powder may be kept to be uſed when wanted: it is introduced into ſeveral compoſitions.

When it is wanted to make the electuary, one part of that powder muſt be mixed in three parts of ſkimmed honey boiled to the conſiſtence of a liquid electuary.

Virtues.—The *hiera picra* is employed to purge the ſtomach, to raiſe the obſtructions, to provoke the menſes and the piles, and to purify the blood. ——The *doſe* is from a drachm to half an ounce in bolus, by reaſon of its extreme bitterneſs. It is alſo uſed in clyſters for the colick, the hyſtericks, and the apoplexy; from two drachms to an ounce for each clyſter.

Hiera picra are two *Greek* words, the firſt whereof ſignifies *great* and *ſacred*, and the other *bitter*.

The purgative virtue of the *hiera picra* conſiſts in the aloes.

Hiera picra reformata. ℞ *Aloes ſuccotrinæ* ℥ ij. *agarici trochiſcati, & tartaris ſolubilis ana* ℥ j. *diacrydii* ʒ vi. *Mellis deſpumati* ℥ xiij. *fiat electuarium,* S. A.

Virtues.

Virtues.—This *hiera picra* purges with violence enough; it is uſed for the windy colick, the apoplexy, lethargy, and epilepſy.—The *doſe* is from half a drachm to three drachms.

Distilled Waters.

I do not deſign to mention in this place, thoſe which depend purely on Chymiſtry, as the aqua-fortis, the common brandy, the ſtyptick and phagedenick waters.

Distillation is a rarefaction and exaltation of the moſt humid and eſſential parts of the mixts, reſolved by fire into vapours, which aſcending to the capital, and being cool'd there, are condenſed into drops which fall into the receiver.

Diſtilled waters are divided into *ſimple* and *compoſed*.

Simple diſtilled waters are thoſe extracted from the plant without addition, as plantain, roſe, and ſorrel-water, *&c.*

Compoſed diſtilled waters are thoſe diſtilled from ſeveral ingredients, as treacle-water, imperial-water, aqua mirabilis, *&c*,

The artiſt muſt uſe, as much as poſſible, glaſs or earthen veſſels for the diſtillation of waters; but when thoſe veſſels are not large enough to contain the matter to be diſtilled, he muſt then uſe copper-alembicks tinned inſide.

There are two ſorts of *diſtillations*, one done *per aſcenſum*, and the other *per deſcenſum*.—The firſt, and moſt common, is when the matter is heated underneath. The other is when the fire is put over the matter to be heated: then as the vapour cannot riſe, it is precipitated to the bottom of the veſſel.

As the mixts, from which the waters are extracted, are of different ſubſtances, the one volatile, the other fix'd, ſome watery and phlegmatick, and others dry and ſaline; different means muſt be uſed to carry off by diſtillation as much of their moſt eſſential parts as poſſible. I'll give models to ſucceed in it.

The diſtilled waters can be kept ſeveral years without corruption; becauſe there have been ſeparated from them, by the diſtillation, the fermenting ſubſtances which would ſpoil them: but they muſt be renewed every year, becauſe the vitriol they have brought along with them from the plant, is much weaken'd in winter.

Plantain water. Take what quantity you will of large plantain, newly gather'd, in its greateſt vigour; have pounded in a mortar enough of it to fill half a large copper-cucurbit, tinned inſide: mean while muſt be extracted by expreſſion, in the uſual manner, eighteen or twenty pounds of the juice of other plantain, which you'll pour over the pounded plantain to humect it well, ſo that it may not ſtick to the bottom of the veſſel during the diſtillation. Place the cucurbit over a furnace, covering it with its bolt-head, garniſhed with its refrigeratory, which muſt be filled with cold water; then adapt to it a receiver, and light a charcoal fire in the furnace, to diſtil the humidity moderately quick, ſo that one drop may follow the other.

When about half the humidity is diſtilled, the fire muſt be left to go out; and when the veſſels are cold, the plantain muſt be taken out of the alembick, ſtrained by expreſſion, and afterwards thrown away as uſeleſs; but the juice extracted from it muſt be poured back into the ſame veſſel, and the diſtillation renewed, which ſhould be continued, till there is but little of the liquor left in the veſſel.

The diſtilled *plantain-water* muſt be expoſed for ſome days to the ſun, in glaſs or ſtone bottles uncorked, to diſſipate the ſmell of empireum, which proceed from the fire; after which the bottles muſt be corked: and the water kept for uſe.

Virtues.—Plantain-water is deterſive, aſtringent cooling, proper to ſtop the looſeneſs, the hæmorrhages, the gonorrhœa's, *&c.*——The *doſe* is from an ounce to ſix.——It is alſo uſed outwardly to waſh the eyes in the ophthalmicks; and for deterſive and aſtringent injections.

In the ſame manner can be diſtilled the waters from all the plants, which abound in humecting and cooling phlegm; and if the juice of ſome of them cannot be extracted eaſily, there muſt be made a ſtrong decoction thereof to humect the pounded herbs.

The waters which can be thus diſtilled are thoſe of *purſelain, lettuce, ſempervivum, bugle, henbane, mandragora, mallows, borage, bugloſs, ſolanum, alkekengi, verbaſcum, agrimony, nenuphar, poppies, alchimilla, ſenicle, chelidonium*, &c.

Sorrel-water.——Take what quantity you will of very green and tender ſorrel, gathered in fair weather while it is in its greateſt vigour, and before it is grown into ſeed; pound it or bruiſe it in a ſtone or marble mortar, fill with it about half a large copper-cucurbite, tinned inſide; pour over the matter a good quantity of juice of ſorrel, newly extracted with expreſſion, ſo that the liquor ſwim over the matter, adapt to the cucurbite its capital, with its bolt-head, tinn'd likewiſe inſide, and its refrigeratory; place the veſſel over a naked fire; adapt a receiver to the cucurbite, and diſtil the humidity at a pretty ſtrong heat, ſo that th drops follow cloſe one another.——When about half the humidity has been diſtilled, the veſſels muſt be left to cool; and when cold, what is left in the cucur-

bite

bite muſt be taken out and carried to the preſs to extract the juice; that juice muſt be left to ſettle, and having been afterwards ſtrained through a flannel, it muſt be put in an earthen pan, to have evaporated over a ſlow fire about two thirds of the humidity thereof, carrying afterwards the veſſel to a cool place, where it muſt be left for ſome days without touching it; then there will be formed round it ſmall cryſtals which are the eſſential ſalt of the ſorrel which muſt be ſeparated from the reſt, and kept for uſe.

But if one will not take the trouble to prepare the eſſential ſalt of ſorrel, he may content himſelf with evaporating the juice to the conſiſtence of thick honey; which will be the *extract of ſorrel*.

The ground taken from the preſs muſt be dried, and having mixed with it a good quantity of other dried ſorrel, the whole muſt be burnt, the aſhes thereof calcined, and having made a lixivium of thoſe aſhes, it muſt be filtrated, and afterwards put to evaporate to ſiccity, over a ſlow fire; there will be found at the bottom of the veſſel a ſalt, which is the *fix'd ſalt of ſorrel*, and which muſt be kept for uſe.

Virtues.——The *water of ſorrel* is eſteemed cordial, cooling; proper for violent and bilious fevers. ——The *doſe* is from an ounce to ſix.

The *eſſential ſalt of ſorrel* is inciſive, penetrating, rarefying; it provokes the appetite, and is cordial. ——The *doſe* is from half a ſcruple to half a drachm.

The *extract of ſorrel* has very near the ſame virtues of the eſſential ſalt; but the *doſe* muſt be greater, *i. e.* from a ſcruple to a drachm.

The *fixed ſalt of ſorrel* is aperitive, penetrating, proper to raiſe the obſtructions.——The *doſe* is from eight grains to half a drachm.

In the ſame manner can be diſtilled the other plants which have no ſmell, and are ſaline; as the *carduus benedictus*, *naſturtium*, *ſcabioſe*, *fumitery*, *parietary*, *chicory*, *tobacco*, *ſmall centaury*, *St. John's-wort*, *tuſſilage*, *endive*, *chamædryos*, *chamepityos*, *pœony*, *enula campana*, *cochlearia*, &c. theſe waters muſt be made to diſtil pretty quick, that they may exalt along with them ſome portion of the eſſential ſalt of the plant; for in that ſalt conſiſts all the virtue of thoſe waters which have no ſmell; wherefore thoſe plants are never to be diſtilled in balneo mariæ, nor in balneo vaporis, which would only exalt the pure phlegm. But whatever method and precaution may be obſerved in the diſtillation of thoſe, it always happens that the greateſt part of their active and eſſential principles remain in the bottom of the cucurbite; therefore it would be better to uſe the juice, or of a ſtrong decoction of the plant, while it is in its vigour, than of its diſtilled water; but when we have no more the plant in its vigour, the diſtilled water can be uſed: and to render it more efficacious, there muſt be diſſolved in it, before it is taken, ſome of its eſſential ſalt, or of its extract or fixed ſalt; which will very well ſupply the want of the plant in its vigour. Theſe diſtilled waters muſt be expoſed for ſome time to the ſun, the bottle uncorked, that the empyreumatical ſmell may be diſſipated.

Wormwood-water.——Take a good quantity of common wormwood, green, newly gathered while in its greateſt vigour; pound the leaves thereof in a mortar, and fill with it half a large copper cucurbite tinned inſide; mean while make a ſtrong decoction of other wormwood, ſtrain it boiling-hot, and pour as much of it upon the wormwood in the cucurbite as is neceſſary to humect it leſt it ſhould ſtick to the bottom of the veſſel, which muſt be very well ſtopped, and the matter left in digeſtion for two days; which expired, the veſſel ſhall be unſtopped, placed on a furnace, the bolt-head with its refrigeratory, and a receiver adapted to it, the joints luted, and at a moderate fire, about half the humidity diſtilled; which done, and the veſſels cold, they muſt be opened, the matter left in the cucurbite ſtrained, and the juice extracted from it put to diſtil as before, there will be no more but two or three pounds thereof left. The diſtilled water muſt be kept in bottles well corked.

Virtues.——The *water of wormwood* is proper to incite and attenuate the pituita, to ſtrengthen the ſtomach, to excite the appetite, to help digeſtion, provoke the menſes, abate the vapours, and for the worms.——The *doſe* is from half an ounce to four ounces.

The liquor left in the alembick of the diſtillation may be clarified, and the humidity thereof evaporated to the conſiſtence of honey, which will be the *extract of wormwood*. It is aperitive, and proper for the hyſtericks.——The *doſe* is from a ſcruple to a drachm, either diſſolved in its proper water, or taken in a bolus. The grounds left after they have been dried, can alſo be burnt with other *wormwood*; and the aſhes put in warm water to make a lixivium, which having been filtrated, is put to evaporate to ſiccity, and what is left in the bottom of the veſſel is the *ſalt of wormwood*, which muſt be kept in a bottle well corked. This *ſalt* is very aperitive, proper to raiſe the obſtructions of the liver, of the ſpleen, meſentery, and of the matrice, to provoke the urine, for the yellow jaundice, the hydropſy, and the retention of the menſes.—— The *doſe* is from ſix grains to half a drachm, diſſolved in water of wormwood.

By the ſame method are extracted the waters, eſſences, extracts, and ſalts of all odorous plants, viz.

viz. of *mint*, *ſage*, *marjoram*, *ſavine*, *roſemary*, *henbane*, *hyſſop*, *marrubium*, *mugwort*, *honey-ſuckles*, *ſcordium*, *lavender*, *parſley*, *fennel*, *muſtard*, *bays*, *rue*, *betony*, *camomile*, *origan*, *melilot*, *matricaria*, *juniper*, &c.

Roſe-water.—Take what quantity you will of pale or white roſes, newly blown, the moſt odorus, and gathered ſoon after ſun-riſing, in dry weather; pull the leaves off their pecule, and having pounded them in a marble mortar, put them in a copper cucurbite tinned inſide, pouring upon them the juice of other roſes newly extracted by expreſſion, to humect them well, or elſe it may be done with roſe-water of the preceding year; then place the veſſel in balneo mariæ or vaporis, and cover it with its capital garniſhed with a refrigeratory; adapt a recipient to it, lute exactly the joints, and leave the matter in digeſtion for two days; which expir'd, placed to the diſtillation by a good fire, taking care to change the water of the refrigeratory as it grows hot. When about the two thirds of the liquor is diſtilled, the fire muſt be put out; and what is left in the veſſel carried to the preſs to extract the juice, which muſt be put to diſtil as before, to have good roſe-water, which muſt be expoſed to the ſun for two days in uncorked bottles, to ſharpen its ſmell; then the bottles muſt be well corked.

Virtues.—Roſe-water ſtrengthens the breaſt, heart, and ſtomach.—The *doſe* is from one ounce to ſix. It is alſo uſed in collyres for the maladies of the eyes; and in perfumes.

Inſtead of white and pale roſes, purple roſes were uſed in the diſtillation, the water drawn from them would be aſtringent, and proper to ſtop the looſeneſs, for the ſpitting of blood, for deterſive injections. It would even be better than the other for collyres; but it would have but very little ſmell: beſides, it would be the moſt proper roſe-water for the maladies in which that remedy is commonly uſed; and it could be wiſhed that the world which often will be deceived, would not mind ſo much the ſmell of this water to judge of its goodneſs; the apothecaries would make it of red roſes, and then it would produce better effects.

In the ſame manner can be extracted the water of all flowers, as, of the *flowers of poppies*, of *nenuphar*, of *lilies of the valleys*, of *borage*, of *beans*, of *roſemary*, of *bugloſs*, of *violets*, of *jeſſamine*, of *tuſſilage*, of *oranges*, of *lavender*, of *thyme*, of *ſage*, &c. But as a great number of thoſe flowers are very little ſucculent to extract the juice thereof, they muſt be humected before diſtillation, with a ſtrong infuſion of another quantity of the ſame flowers made ſometimes in hot water, and ſometimes in white-wine according to their quality.

Water of ſtrawberries.—Take four or five pounds of ripe ſtrawberries, bruiſe them in a marble mortar, and put them in a large glaſs cucurbite, which muſt be placed in balneo mariæ, and having adapted a capital to it, and a receiver, and luted exactly the joints, as much of the humidity of the fruits as poſſible ſhall be diſtill'd by a pretty ſtrong fire.

Virtues—The *water of ſtrawberries* is good to ſtrengthen the heart, the brain, and to enrich the blood.—The *doſe* is from an ounce to three. Ladies uſe it to waſh their face.

In the ſame manner can be drawn the water of the other ſucculent fruits, as of *cherries*, *plumbs*, *apples*, *mulberries*, *raſberries*, *barberries*, *quinces*, *peaches*, *oranges*, *lemons*, *elderberries*, *melons*, *cucumbers*, *pumpkins*, *gourds*, &c.

Strawberry-water is made in ſeveral other manners; ſome leave the fruit bruis'd to ferment two or three days, that its principal may be exalted before diſtillation. Others humect their ſtrawberries with white-wine to render the water more ſpirituous and more aperitive; and others humect them with aſs's milk, to make it more proper to beautify the ſkin.

Water of walnuts.—Take a good quantity of flowers of walnut-tree newly gathered, while in their vigour, and let ſix pounds thereof be pounded in a mortar, and put them afterwards in a copper cucurbite; mean while make a ſtrong decoction of other flowers, and after it has been ſtrained by expreſſion pour twelve pounds thereof hot into the cucurbite, or as much as is wanted to humect the pounded flowers; place the veſſel on a furnace, where it muſt be left in digeſtion for twenty-four hours, diſtilling afterwards about half the liquor; which done, the fire muſt be put out, and when the veſſels are cold, what remains in the cucurbite muſt be ſtrained, and three quarters of the juice extracted by that means, diſtilled, mixing afterwards both waters together.

Then you muſt gather ſix pounds of walnuts, when they are about a third of their uſual bigneſs; and having pounded them in a mortar, you muſt put them in a large copper cucurbite, pouring upon them all the diſtilled water of the flowers of walnuts, and leaving the matter in digeſtion for twenty-four hours; and having diſtilled the water as before, you'll take next ſix more pounds of whole walnuts when they are good to preſerve; pound them well in a mortar, and having put them in a copper cucurbite, pour upon them the diſtilled water, and having left the whole in digeſtion for twenty-four hours, proceed to the diſtillation as before, and you'll have the water of walnuts, which muſt be expoſed five or ſix days to the ſun, in uncorked bottles, to diſſipate the empyreumatical ſmell, then cork the bottles.

Virtues.

Virtues.——The water of walnuts is ſudorifick, proper for malignant fevers, for the plague, the ſmall pox, the windy colick, the hyſtericks and to ſtrengthen the ſtomach.——The *doſe* is from one ounce to ſeven.

If after each diſtillation, the liquor left in the cucurbite be ſtrained through a flannel, the humidity thereof evaporated to the conſiſtence of honey; and thoſe three juices thus inſpiſſated be mixed together, it will be a very good extract of walnuts, which muſt be kept in a pot.

Virtues.—The extract of walnuts is ſudorifick, aperitive, febrifuge, ſtrengthens the ſtomach, and reſiſts the malignity of the humours.——The *doſe* is from a ſcruple to a drachm, in a bolus, diſſolved in its proper water.

The grounds left in the preſs can alſo be burnt, to draw from them an alkali ſalt fix'd, by means of a lixivium.

Virtues.—The *fix'd ſalt of walnuts* is aperitive, and proper to raiſe the obſtructions.——The *doſe* is from ſix grains to a ſcruple.

Water of cow-dung.——In the month of *May*, when the graſs begins to have ſome vigour, gather the cow-dung, newly made, and having filled with it half of a glaſs or ſtone cucurbite, place it in balneo mariæ, and by a pretty ſtrong fire, diſtil a clear water, which is called the *water of a thouſand flowers*, and which muſt be expoſed to the ſun in glaſs bottles for five or ſix days, that the diſagreeable ſmell, which it may have, be diſſipated. Then the bottles muſt be cork'd and kept.

Virtues.—This water is aperitive and ſweetening; it is preſcribed for the hydropſy, rheumatiſm, and the ſciatica.——The *doſe* is from an ounce to ſix. It is alſo uſed outwardly, to cleanſe, cool, and ſoften the ſkin: it is reſolutive.

The name of *water of a thouſand flowers*, has alſo been given to the urine of a cow, newly voided from the animal; and it is uſed with ſucceſs for ſeveral maladies in the ſpring and autumn; by drinking two or three glaſſes thereof every morning faſting, for nine or ten days ſucceſſively, and taking a walk afterwards in the fields——That urine purges very well the ſeroſities without griping; is proper for the aſthma, the hydropſy, rheumatiſm, gout, and vapours.

Water of all flowers.——You muſt gather in the month of *May* cow-dung, newly made, weigh it and put it in a large cucurbite of glaſs or ſtone, mixing with it about the third of its weight of white wine; and having placed the veſſel in balneo mariæ, or vaporis, adapt a capital and a recipient to it, and lute exactly the joints, you'll diſtil the humidity of the matter which is called the water of all flowers.

Virtues.——This water is thought arthritic, good for the rheumatiſm, the ſciatica, gravel, and the ſuppreſſion of urine.——The *doſe* is from an ounce to four. It is alſo uſed to cleanſe and ſoften the ſkin, for pimples, itchings, and ring-worms.

Water of the frey of frogs.—Gather in the ſpring, about the month of *March*, what quantity you will of frey of frogs, very pure, condenſed, or thick, and which has a ſmell, diſtil the humidity thereof in balneo mariæ, or in the common manner; and expoſe the diſtilled water to the ſun for ſeven or eight days; and afterwards cork the bottles well to keep them for uſe.

The water of the frey of frogs is very cooling, condenſating, proper for the hæmorrhages, to appeaſe the pain of the gout, for cancers, eryſipelas, and other redneſſes of the ſkin. It is applied outwardly with linen cloths. It is uſed to cleanſe the face, and keep up a freſh complexion.

In the ſame manner are diſtilled, the waters of *milk*, of *blood*, of *human brain*, of *honey*, of *manna*, of *rain*, and of *dew*.

Water of ſnails.—Take three pounds of ſnails alive, with their ſhells, waſh them well, and bruiſe them in a marble mortar, and put them afterwards into a large cucurbite, pouring over them two pints of aſs's milk, newly milked; mix well the whole together with a wooded ſpatula; and having adapted a capital and receiver to the cucurbite, and luted exactly the joints, leave the matter in digeſtion for twelve hours, proceeding afterwards to the diſtillation; which done, the water muſt be expoſed for ſeveral days to the ſun, in a bottle uncorked.

Virtues.——This water is humecting, cooling, proper for the redneſs of the ſkin, to waſh the face, and render the ſkin ſmooth. It can be alſo adminiſtered inwardly, for the ſpitting of blood, the nephritick, and the heat of urine. The *doſe* is from one ounce to ſix.

Aqua vulneraria. ℞. *Foliorum & radicum conſolidæ majoris, foliorum ſalviæ, arthemiſiæ, buglæ, ana man.* iv. *Betonicæ, ſaniculæ, bupthalmi, ſymphyti minoris, ſcrophulariæ majoris, plantaginis, agrimoniæ, verbenæ, abſinthii, fœniculi, ana man.* ij. *Hyperici, ariſtolochiæ longæ, telophii, veronicæ, centaurii minoris, milleſolii, nicotian. menthæ.*

After you have gather'd the herbs in their greateſt vigour, hatch them and pound them well in a mortar, and having put them afterwards in a veſſel of a narrow neck, pour over them white wine, ſtir the whole, ſtop the veſſel, and put it in the horſe-dung, or in another warm place, where it muſt be left in digeſtion for three days; which expired, you'll diſtil the matter in balneo mariæ, or vaporis, extracting above half the humidity, and having left the veſſels to grow cold, what remains in the bottom

tom of the cucurbite, muſt be put to the preſs, and the juice extracted from it, diſtilled as before; mixing afterwards the firſt and ſecond water together, to keep it in a bottle well corked for uſe. This water is called *water of arquebuſade*, becauſe uſed for wounds made with fire-arms.

Virtues.——This water is good for the contuſions, diſlocations, to reſolve tumours, to cleanſe ulcers and wounds; and to reſiſt the gangrene, applied outwardly.

Hungary-water.——Fill half of a glaſs-cucurbite with flowers of roſemary, newly gathered in their vigour, pour over them ſpirit of wine till it ſurpaſſes the flowers by two fingers breadth, cover the cucurbite with its capital, and leave the matter in digeſtion for three days; and afterwards, having adapted a receiver to it, and luted exactly the joints, proceed to the diſtillation at a ſand-heat; and keep the diſtilled water in a bottle well corked for uſe.

Virtues.——This water is good for the palſy, apoplexy, lethargy, the hyſtericks, palpitations, for fainting-fits, and the pain of the ſtomach.—— The *doſe* is from one drachm to three.——It is alſo uſed outwardly for the tooth-ach, the burns, the cold humours, contuſions, to cleanſe the ſkin, to ſtrengthen debilitated members, for the vapours, being applied to the noſe and temples, and on the wriſts; and for the gangrene.

Aqua theriacalis. ℞. *Radicum gentianæ, angelicæ, imperatoriæ, valerianæ, contrayervæ, āa* ℥ ij. *Corticum citri & arantiorum, caryophyllorum, cinnamomi, baccarum juniperi, āa* ℥ j. *Summitatum ſcordii, rutæ, hyperici, āa man.* j.

Let all theſe drugs be infuſed for three days ſucceſſively in balneo mariæ, in ſpirit of wine and water of carduus benedictus and walnuts, of each two pints; and after you have added to it four ounces of old treacle, put the whole mixture to macerate for the ſpace of twenty-four hours; then proceed to the diſtillation by a ſlow fire; to have the treacle-water, which muſt be kept in a bottle well corked.

Virtues.—This water is proper to ſtrengthen the noble parts, to reſiſt the bad air, to raiſe the ſpirits, to expel bad humours by perſpiration; it is uſed in the apoplexy, palſy, lethargy, and epilepſy.—The *doſe* is from a drachm to ſix.

Aqua mirabilis. ℞ *Cinnamomi electi* ℥ j. *Corticis exterioris citri, nucis moſchatæ āa* ʒ vj. *Caryophyllorum, calangæ, cubebarum, macis, cardamomi, zingiberis āa* ʒ ij.

Having bruiſed all the drugs together, they ſhall be put in a glaſs cucurbite, and the juice of the meliſſa depurated, white-wine and ſpirit of wine poured upon them; and having left the mixture to macerate for three days ſucceſſively; you muſt proceed to the diſtillation at a moderate ſand-heat: then you'll have the *aqua mirabilis.*

Virtues.—This water ſtrengthens all the noble parts, rejoices the heart and the brain, and provokes the menſes.——The *doſe* is from two drachms to ſix.

Aqua carminativa, ſeu ſpiritus carminativus, fr. delebœ ſilvii. ℞ *Summitatum centaurii minoris, foliorum roriſmarini, majoranæ, rutæ hortenſis, baſilici, āa man.* ſs. *Cinnamomi,* ʒ vj. *Seminum angelicæ, leviſtici, aniſi, āa* ℥ ſs. *Baccarum lauri,* ʒ iij. *Nucis moſchatæ, macis, radicum imperatoriæ, galangæ, zingiberis, aa* ʒ j. ſs. *Angelicæ, caryophyllorum, corticis arantiorum, aa* ʒ j. *Conciſis, & craſſe contuſis affunde, ſpiritus vini,* lb. ij. ℥ iv. *Digerantur per biduum in balneo mariæ, hinc ad ſiccitatem diſtillentur; ſervetur diſtillatus ſpiritus ad uſum.*

Virtues.—This ſpirit is proper for the windy colick; it diſunites and rarefies the ſlimy matters, and appeaſes the gripes.——The *doſe* is from half a drachm to two drachms.

Aqua pectoralis, Georgii Batei. ℞. *Ligni guaiaci pulverizati,* ℥ viij. *Radicum helenii, ariſtolochiæ rotunæ, āa* ℥ iij. *Iridis noſtratis,* ℥ j. ſs. *Petroſelini, fœniculi, glycyrrhiſæ, aa* ℥ j. *Foliorum nicotianæ viridium man.* iv. *Scabioſæ, veronicæ, tuſſilaginis, hyſſopi, ſummitatum marrubii, cardui benedicti, aa man.* i. *Jujubas, ſebeſten, aa* No. XXX. *Caricas, dactylos, aa* No. XV. *Baccarum lauri,* ʒ vj. *Seminis nicotianæ,* ʒ iij. *Nigellæ,* ʒ j. *Lini, urticæ, naſturtii, ſinapi, aa* ʒ ij.

Put in a large glaſs or ſtone cucurbite the guaiac reduced into a coarſe powder, the roots cut in pieces, the leaves hatched and bruiſed, the fruits open and cut in ſmall pieces, the berries and ſeeds bruiſed, and two ounces of turpentine diſſolved with five or ſix yolks of eggs, and afterwards into white wine. Stir the whole together, cover the veſſel and leave the matter in digeſtion, in a warm place, for three days; then uncover the veſſel, adapt a capital, and a receiver to it; and having ſuſpended in the neck of the alembick a piece of fine linen cloth, containing ſixty millepedes, dried and bruiſed, lute exactly the joints, place the cucurbite in balneo mariæ, and diſtil the matter by a pretty ſtrong fire, and the water in diſtilling paſſing over the knot, will be impregnated with the ſubſtances and quality of the millepedes; which water muſt be kept in bottles well corked.

Virtues.—— This water is excellent for the aſthma, for the difficulty of reſpiration, for the cough, to attenuate the coarſe humours of the lungs and of the reins for the nephritick, for the ulcers of the bladder, and to provoke the urine.

——The dose is from one ounce to two, taken twice or thrice a day.

Aqua nephritica. ℞. *Melli optimi*, lb j. *Terebinthinæ cleræ*, ℥ ij. *Ligni nephritici, radicis aronidis*, āa ℥ j. ſs.

Having pounded the woods and roots, all the drugs muſt be put to macerate in the beſt white wine, and lemon-juice, newly extracted, of each two pounds; diſtilling the liquor afterwards by a moderate fire.

Virtues.—This water is proper to expel the gravel from the reins and the bladder; and is given for the nephritick.——The *doſe* is from half an ounce to four ounces.

Water to appeaſe the pains of the gout.——Let ox's dung be dried in the ſun, and mix it afterwards with freys of frogs, an equal quantity of each, in a glaſs cucurbite, to which having adapted a capital with its receiver, and luted exactly the joints, proceed to the diſtillation of the humidity in balneo mariæ; and you'll have a water which muſt be kept in a cool place for uſe.

Virtues.—This water is eſteemed good to appeaſe the pains of the gout, attended with inflammation of the part, by applying upon it pieces of linen cloth dipped into it.

A very good eye-water.—Take the flowers of cyanus, newly gather'd in their vigour, pound them in a marble mortar, with a ſufficient quantity of ſnow-water to humect them well; put them in a glaſs or ſtone cucurbite, and having adapted a capital to it with its recipient, leave the matter in digeſtion, by a ſlow heat in balneo mariæ, for a whole day; and having diſtilled afterwards the humidity, you'll expoſe the diſtilled water to the ſun, for ſome days, in a bottle uncorked; and keep it afterwards for uſe.

Virtues.—This water is proper for inflammations, and other maladies of the eyes; it cools them, and ſtrengthens the fibres thereof, by waſhing the eyes with it, and ſuffering ſome drops thereof to enter them.

Aqua epidemica, Georgii Baiei. ℞ *Foliorum chelidoniæ, roriſmarini, rutæ, arthemiſiæ, abſinthi, anagallidis, dracontii, ſcabioſæ, agrimoniæ, meliſſæ, ſcordii, centauri minoris, cardui benedicti, betonicæ, roris ſolis, ana man.* ij. *Radicum angelicæ, tormentillæ, gentianæ, zedoariæ, glyzyrrhizæ, ana* ℥ j. *Macerentur in vini albi* lb. viij. *Per duos dies; deinde diſtillentur ſecundum artem.*

Virtues.—This water is uſed in the epidemical maladies; as in the ſmall-pox, the malignant fever, and the plague.——The *doſe* is from half an ounce to two ounces; or from half a ſpoonful to four.

Aqua lavendulæ compoſita. ℞. *Florum lavendulæ, lilii convallium, āa man.* vj. *Salviæ, roriſmarini, pæoniæ, tiliæ, aa pug.* j. *Radicis pæoniæ, erucæ, aa* ℥ ij. *Galangæ, zingiberis, calami aromatici, nuciſtæ, cubebarum, cinnamomi, macis, caryophyllorum, viſci quercini, aa gr.* xxvj. *Vini optimi, q. ſ. Fiat infuſio & diſtillatio in balneo mariæ.*

Virtues.——This water is cephalick and arthritick, it ſtrengthens the brain and the joints, and may be uſed in the epilepſy, palſy, and apoplexy.——The *doſe* is from two drachms to an ounce.

Water to prevent the accidents which may be occaſioned by a fright or a fall of a woman with child.——Take an ounce and a half of cinnamon: half an ounce of cubebs; three drachms of cloves; mace, galanga, ginger, zedoary, ſaffron, of each two drachms; a handful of flowers of lavender, and two quarts of water of lilies of the valley, diſtill'd with the beſt white wine. Bruiſe well the ingredients, put them into a cucurbite, and having pour'd upon them the water of lilies of the valley, ſtop well the veſſel, and place it in horſe-dung, where you'll leave it four days in digeſtion; which elapſed, open the cucurbite, adapt a capital to it with its receiver, lute exactly the joints, and diſtil the humidity in balneo mariæ, to extract a water which muſt be kept in a bottle well corked.

Virtues.—This water is proper for women with child which have been frighten'd, or having fallen down; for it prevents abortion, by ſtrengthening both the mother and child: it alſo helps the digeſtion—The *doſe* is from two drachms to an ounce.

Elixirs.

The name *elixir* comes from the *Greek* ἀναξω, *traho*, becauſe in mixing an *elixir*, the pureſt ſubſtance of the mixts is extracted: or from ἀυξίω, *auxilior*, becauſe of the great benefits received from them in medicine. *Elixir* is ſometimes called *enchilana.*

Elixir is a ſpirit or quintiſſential tincture of ſeveral choſen mixts, containing their pureſt ſubſtance. It is deſigned for inward uſes,

Elixir proprietatis. ℞. *Myrrhæ electa, aloes ſuccotrinæ, aq* ℥ ij. *Croci orientalis*, ℥ j.

The myrrh and aloes muſt be pounded together, and put with the ſaffron in a matraſs, pouring upon them ſpirit of wine, that it may ſurpaſs the matter by a finger's breadth; then the matraſs muſt be well ſtopped, and carried to a warm place; where the matter is to be left two days in digeſtion, which elapſed, the matraſs is open'd, and the acid ſpirit of ſulphur having been added to the infuſion, to the height of four fingers breadth, the matraſs muſt be corked again, and placed in digeſtion in the ſun, or in a lukewarm balneo mariæ, where having

having been left four days, the liquor muſt be filtrated afterwards, and kept in a bottle well corked.

Virtues.——This *elixir* ſtrengthens the heart and the ſtomach, purifies the blood, provokes the menſes, abates the hyſterick vapours, and is ſudorifick ——The doſe is from four to ſixteen drops.

Elixir ſincopticum. ℞ *Corticis exterioris citri* lb ſs. *Croci orientalis* ʒ vj. *Antidoti orvietani* ʒ ſs. *Confectionis alkermes, diambræ, âa* ʒ ij. *Succi limonum depurati* lb j. *Aquarum roſarum* ʒ ix. *Meliſſæ* lb ſs. *Florum trium cordialium, calendulæ, lilii convallium, roris ſolis, aa* ʒ iv. *Tunicæ* ʒ iij.

You'll take the outward rind of lemon ſeparated from the whole part, and having cut it ſmall, you'll put it with the ſaffron in the matraſs, together with the orvietan and confection alkermes diſſolved in the diſtilled waters; then ſtop exactly the matraſs and place it in the horſe-dung, where the matter muſt be left in digeſtion for fifteen days; pouring afterwards the infuſion into a glaſs or ſtone cucurbite, and having adapted a capital to it with its recipient, lute exactly the joints and put in the pipe of the alembick four ſcruples of powder of diambra, tied in a piece of linen cloth, you'll diſtil the liquor in balneo mariæ.

Virtues.—This *elixir* is good againſt fainting fits, ſincope and the apoplexy.—The *doſe* is from two drachms to an ounce and a half.

Of Oils *in general.*

By the name *oil* is properly underſtood, the unctuous juice or fat ſubſtance extracted by expreſſion from *olives*; for *oleum*, which is the *Latin* name, comes from *olea*, or ἐλαία, which ſignifies *olive-tree*, or *olive*: however, all fat and inflammable liquor, from what part ſoever it be extracted, is called *oil*; the greaſe of animals are but congealed *oils*, by the mixture of the volatile ſalts, and of a little phlegm. The fruits, berries, and ſeeds abound in *oil*; and generally all combuſtible matters are no otherwiſe inflammable but by means of the *oil* they contain.

Oils may be divided into natural and artificial.—The *natural* are, as the *liquid amber* and the *turpentine*, which come out through the inciſions made in trees; and the *petroleum* which run through the clefts of rocks. The *artificial* are all the *oils*, extracted by expreſſion, diſtillation, or infuſion.

I'll ſpeak only in this treatiſe of the oils uſed in *Galenical Medicines*; and deſcribe firſt, the *oils extracted by expreſſion*, and paſs afterwards to thoſe *prepared by infuſion*.

The Oil of Olives, which is the moſt common of thoſe extracted *by expreſſion*, is prepared in the following manner.

The *olives* are gather'd when they are ripe, *viz.* in the months of *November* and *December*; they are left to depurate of their watery humidity in ſome corner of the houſe, for ten or twelve days, where having heated themſelves, they are bruiſed afterwards under a mill-ſtone, and then put in frails of ruſhes or palm-trees, which being placed at the preſs, one over another, there comes out an oil by the ſingle compreſſion of the frails, which is called *virgin oil*, and is the beſt.

Next the *olives* are moiſten'd with warm water, to render the *oil* more fluid, and by preſſing them as hard as poſſible, a very good *oil* is extracted from them.

The ſqueezed *olives* are ſtirred, and having pour'd over them a great deal of warm water, more *oil* is extracted by a new expreſſion, which being full of fæces, is worſe than the two firſt: theſe *oils* ſwimming over the water, are eaſily ſeparated from it; but there is found precipitated at the bottom, a thick matter, which is what the antients called *amurca*.

There has never been ſuch a thing as the *omphacine oil*, prepared in the manner deſcribed by the antients; for they pretended that it was extracted by expreſſion from *green olives*, wherefore it was called *omphacium*, becauſe *green olives* have ſome reſemblance with *green grapes*, called in Latin *omphatium*, i. e. crude and aſtringent; for if *green olives* were bruiſed and ſtrained, nothing but a viſcous juice could be extracted from them. Thoſe that want to give to the common *oil*, the qualities attributed to the pretended *omphacine oil*, boil in it the ſummits of black-berry buſhes, of oak, of lentiſc, of honey-ſuckles, and red roſes.

Old oil is commonly requir'd for plaiſters and unguents, becauſe having received ſome fermentation in its inſenſible parts, it becomes thereby more penetrating, and more emollient. It is alſo uſed for aliment, and in clyſters for the colick, the gripes, and the dyſenteria.

Oils *extracted by expreſſion.*

Oil of ſweet almonds.—Take what quantity you will of new and large almonds, ſeparated from their ſhells; rub them well in a coarſe and rough linen cloth (to cleanſe them of a red ſcurff faſten'd to the ſkin) till no more dirt comes off; pound thoſe almonds in a marble mortar, with a wooden peſtle, till they be reduced into a paſte; wrap that paſte in a ſack, or piece of ſtrong linen cloth, put the ſack to preſs between two thin plates of walnut-tree, and having placed underneath a pewter-diſh, or an earthen one glazed, preſs gently the matter at firſt, to make the *oil* run by degrees without burſting the cloth; but when ſome quan-

tity of *oil* is come out, you muſt then preſs the matter as hard as you can; and you'll have a very good *oil of ſweet almonds*, which muſt be kept in a bottle for uſe.

Virtues.—The *oil of ſweet almonds* ſoftens the acrimony of the trachæa, and of the breaſt, provokes the urine, appeaſes the pains of the nephritick, by facilitating the evacuation of the ſtone, gravel, or phlegm, from the reins or bladder; it is good for the after-pains of a lying-in woman, and for the gripes of new-born children.——The *doſe* is from two drachms to an ounce and a half. It is uſed outwardly to ſoften the parts.

The common method is to blanch the almonds before they are pounded, to extract a finer and clear *oil*; but as it is impoſſible to blanch the almonds till after they have been put to ſteep in hot water, they have been thereby impregnated with that water, which running along with the *oil* makes it grow rank if it be kept a little while. Several beat the pounded almonds before they preſs them, to extract more *oil*; but as the fire communicates always ſome diſagreeable ſmell to *oils*, and renders them more acid, it is much better to have a leſs quantity of oil, and good.

The *oil of walnuts* can be extracted in the ſame manner without fire; which oil is proper to appeaſe the colick and the gripes. Ladies uſe it to cleanſe their ſkin.

The *oil of bitter almonds* differs no otherwiſe from that of *ſweet almonds*, than in that it is kept longer without growing rank.

The oils of the ſtones of fruits, and of ſeeds which contain a great deal of oil, are extracted in the manner of that of almonds; but when it is wanted to extract by expreſſion the oil of a ſeed which is very little oleaginous, as is that of anis; or when the oil is naturally congealed, as in the nutmeg, the matter, after it has been well pounded, muſt be heated at the vapour of water or wine, then preſſed hard.

OILS, *prepared by infuſion, or decoction, or by a ſimple mixture.*

Oil of roſes.——Take a pound and a half of red roſes newly gathered, pound them well, and put them into a jug; and having poured on them three pounds of oil of olives, ſtop the jug, and expoſe it to the ſun for ſeven or eight days; which elapſed, boil ſlightly the matter, and having ſtrained it hard through a linen cloth, put the ſame quantity of red roſes in the colature, and proceed to the maceration, coction, and expreſſion as before; and having repeated the ſame operation a third time, you'll have the oil of roſes, which muſt be kept in a pot for uſe.

Virtues.——The *oil of roſes* ſtrengthens and conſolidates, in ſoftening; it reſolves the fluxions, temperates the heat of the reins, and of the head, by anointing the part with it hot.

Oleum liliorum compoſitum, meſué. R. *Florum liliorum alborum* ℥ viij *Maſtiches, calami aromatici, coſti, carpobalſami, āa* ℥ j. *Cinnamomi, caryophyllorum, aa* ℥ ſs. *Croci* ʒ ij. *Olei dulcis* ij. lb. *Miſceantur & macerentur per dies quadraginta, in vaſe obturato, deinde bulliant leviter, & exprimantur.*

Virtues.—This oil of white lilies is reſolutive in heating; it is uſed for the pains of the ſtomach, of the breaſt, of the abdomen, in anointing the afflicted parts therewith: though this ſort of oil is ſeldom uſed; the ſimple oil of white lilies, prepared in the manner of that of roſes, being almoſt always ſubſtituted to it.

Oil of St. John's-wort compoſed.—Take a pound of ſummits of St. John's-wort, in flowers, newly gathered in their vigour, bruiſe them, put them in a jug, and pour over them two pounds of common oil, and three ounces of ſtrong red wine; ſtop the jug, and place it in a warm place, or in balneo mariæ, where the matter muſt be left in digeſtion for twenty-four hours; boil afterwards ſlightly the infuſion, ſtrain it with expreſſion, and having put in the colature as much flowers as before, proceed to the infuſion, coction, and colature; repeating once more the ſame operation, except that the third time the infuſion muſt boil longer, to procure the diſſipation of the aqueous juice. After the oil has been ſtrained for the laſt time it muſt be left to ſettle, and afterwards decanted gently, to ſeparate the fæces; then you'll diſſolve in it at a ſlow heat a pound of the beſt turpentine, and pour the oil while yet hot into a jug, to keep it for uſe.

Virtues.—The *oil of St. John's-wort* attenuates, is digeſtive and reſolutive: it appeaſes the pains cauſed by a viſcous humour; it is uſed to ſtrengthen the nerves and the joints, and for the ſciatica. It is an efficacious balſam to cure wounds.

Oleum croci. R. *Croci, calami aromatici, ſeminis carvi, āa* ℥ j. *Myrrhæ* ℥ ſs.

Let the ingredients infuſe together after they have been pounded in a pint of red wine for ſix days ſucceſſively in a glazed earthen pot; then boil the infuſion at a ſlow fire, with a pint and a half of common oil, to the entire conſumption of the wine; which done, ſtrain it and keep it for uſe.

Virtues.——This *oil of ſaffron* diſſipates hardneſs, appeaſes the pains of the matrice and other parts; it ſtrengthens the nerves by anointing the afflicted parts with it.

Oleum moſchatum. R *Florum liliorum, folii indi, maſtiches*

maſtiches coſti, ſpicæ nardi, āa ʒ ſs. *Ligni aloes, coſſiæ ligneæ, myrrhæ, croci, ſtyracis calamitæ, āa* ʒ ij. *Bdellii, cubebarum, caryophyllorum, aa* ℈ jv, *Nucis moſchatæ* ℈ ij. *Moſchi* ℈ j. *Olei communis* ij. lb. *Vini generoſi* lb ſs.

All the drugs except the muſk having been ſlightly pounded, muſt be put to infuſe with the wine and oil for ſeven or eight days, in a glazed earthen pot, and boiled afterwards to almoſt the entire conſumption of the wine; after which the liquor is ſtrained and kept for uſe.

Virtues.——This *oil* is proper to ſtrengthen the nerves, matrice, ſtomach, to expel wind, and to reſolve coarſe humours, by anointing the parts therewith.

Oleum carminativum reformatum. R. *Oleorum diſtillatorum ſeminis cymini,* ʒ ſs. *Aniſi,* ʒ ſs. *Carvi,* ʒ j. *Arantiorum, chamomillæ, ana* ʒ ſs.

All theſe oils muſt be mixed together in a vial, and the mixture kept for uſe.

Virtues.——This oil is proper to attenuate the viſcoſities, to expel winds, to appeaſe the gripes and pains: it is uſed for the melancholicks.—The *doſe* is from three drops to ſix. The region of the ſtomach, and of the navel, can alſo be anointed with it.

Oleum majoranæ. R. *Herbarum majoranæ, man.* iv. *Serpinæ, man.* ij. *Foliorum myrti vel baccarum, man.* j. *Abrotani, menthæ aquaticæ, ana man.* ſs. *Olei communis,* lb. iij.

Let all theſe drugs macerate together for eight days, in a jug well ſtopp'd, and carried to a warm place; then boil the infuſion, ſtrain it by expreſſion, and keep the colature for uſe.

Virtues.—This oil of marjoram is reſolutive, ſtrengthens the brain, and the ſtomach, expels the wind, and worms; is good for the ſciatica, and attenuates the viſcoſities, by anointing the afflicted parts therewith.

Oleum ranarum. Take ten or twelve frogs alive, cut them in pieces, and put them in a glazed earthen pot, pouring immediately upon them a pound and half of linſeed oil; cover the pot very cloſe, and place it in a boiling hot balneo mariæ, where it muſt be left ſeven or eight hours; ſtrain afterwards the infuſion, ſqueezing hard the frogs; leave the colature to ſettle, and decant it afterwards to depurate it of its fæces.

Virtues.—The oil of frogs ſoftens, and temperates the inflammations, promotes ſleep, being applied on the temples, and appeaſes the pains of the gout, by anointing the parts with it.

In the ſame manner can be made the oil of toads, of craw-fiſh, and other aquatick animals.

BALSAMS.

There is ſo great an affinity between *balſams* and *oils*, that they are often confounded together; and that the ſame liquor is ſometimes called *balſam*, and ſometimes *oil*; though there is notwithſtanding this difference, that the *balſams* have generally more conſiſtence than the *oils*.

BALSAMS are divided into natural and artificial. *Natural balſams* are thoſe which come out of trees, thro' inciſions made in them, as the *balſam capayba*, or *capivi*, of *Peru*, &c.—*Artificial balſams* are thoſe prepared by Chymiſtry, and Pharmacy; which balſams are compoſed of oils and eſſences, gums, wax, roſine, powder; according to the different virtues to be given to them: there are balſams prepared for wounds, to preſerve dead bodies, to ſtrengthen, and rejoice the brain, the heart and the ſtomach, to reſiſt venom, for the wounds of the breaſt, and to perfume.

The BALSAM of *arceus* is made (when a conſiderable quantity is wanted) with two pounds of tallow of goats, *Venice* turpentine, and gum elemi, a pound and a half of each; and a pound of hog's-lard. To the gum elemi, cut into ſmall pieces, and liquify'd on a ſlow fire, are added the turpentine, goat's tallow, and hog's lard; when theſe are well diſſolv'd, they muſt be ſtrain'd thro' a piece of new linen cloth, to ſeparate the dregs; the whole muſt be left to cool, and the balſam is made.

This balſam is incarnative, and conſolidates all ſorts of wounds and ulcers; 'tis uſed for the fractures and luxations of the bones, to cure contuſions, and the wounds of the nerves.

To make the *Samaritan balſam*, you muſt take equal parts of oil of olives and good wine, which muſt be boil'd in a glaz'd earthen pot till the wine be entirely conſumed. This balſam mundifies and conſolidates ſimple wounds, eſpecially when they are freſh.

The *Spaniſh balſam* is made by taking wheat, roots of valerian, and carduus benedictus, an ounce of each; all which muſt be well pounded, and put afterwards, with a pint of white wine, in a glaz'd earthen veſſel, narrow a-top, which muſt be well ſtopp'd, and placed on hot embers during 24 hours, adding to it afterwards ſix ounces of St John's-wort, making the whole boil to the conſumption of the wine; after which, 'tis ſtrain'd, and a new addition made to it, afterwards, of two ounces of olibanum, in powder, and eight ounces of *Venice* turpentine; which, after it has been mix'd together over a ſlow fire, the balſam is made.

This balſam was always uſed by *Aquapendente*; 'tis excellent for all ſorts of wounds, even the nervous, which, 'tis ſaid, it will cure in 24 hours. The wound muſt be waſhed firſt with cold white wine,

wine, and then anointed with this balſam hot. If the wound was deep this ſame balſam, alſo made hot, muſt be ſyring'd into it, approaching afterwards the edges of the wound near one another, and anointing them with it. On the wound muſt be put a compreſs dipp'd in the balſam, and another over it, dipp'd in ſtrong wine, and over this another dry compreſs.

To make the green balſam, you muſt take equal parts of linſeed oil, and oil of olives, *viz.* a pound of each, an ounce of oil of bays, two ounces of *Venice* turpentine, half an ounce of diſtill'd oil of juniper-berries, three drachms of verdigreaſe, two drachms of the beſt aloes, two drachms and a half of white vitriol, and a drachm of oil of cloves. The oils of linſeed and olives muſt be put together in a frying pan, over a very ſlow fire, and then muſt be incorporated with the turpentine and oil of bays; after which, the pan having been taken off the fire, and the mixture left to cool, there muſt be mixed with it, by degrees, the verdigreaſe, white vitriol, and aloes, very well pounded; adding to it the oils of cloves and juniper-berries; and the balſam is made.

This balſam is very good for all ſorts of wounds made either with iron, or fire-arms. The wound muſt be waſhed with hot wine, and afterwards anointed with this balſam hot; applying to it pledgets imbib'd with it, and over it a large pledget dipp'd in ſome ſtyptick liquor. This balſam mundifies, incarnates, and cicatrizes the wound; 'tis good againſt the bite of venomous beaſts, fiſtulous, and malignant uicers.

Balſamum vulgare. ℞ *Terebinthinæ Venetæ* lb. j. *Gummi elemi* ℥ iv. *Reſinæ pini* ℥ ij. *Ariſtolochiæ longæ* ℥ i ſs. *Sanguinis draconis* ʒ ij.

The dragon's blood and ariſtoloche muſt be pounded each ſeparately, and the gum elemi and reſine melted with the turpentine over a very ſlow fire; then the whole mixture is ſtrained through a linen cloth to ſeparate the dirt; and the powders having been mixed with the colature, the mixture muſt be kept for uſe.

Virtues.—This balſam is proper for wounds, and old and new ulcers, it cleanſes them, renews the fleſh, ſtrengthens the nerves, and is good for the diſlocations.

Balsam, to make children cut their teeth eaſy. —Take three ounces of freſh butter without ſalt; hen's and duck's greaſe, of each two ounces; and an ounce of flowers of wild red poppies, mix together in a glazed earthen pot the freſh butter, the greaſe, and the flowers, with the mucilage of roots of althæa, and the juice of craw-fiſh, of each two ounces; cover the pot, and place it over a little fire, to make the matter boil gently to the conſumption of the watery humidity; ſtrain the liquor, and mix with the colature four ounces of white ſugar-candy, a ſcruple of troches of gallia moſchata reduced into powder, and the yolk of an egg, to make a *balſam* which muſt be kept for uſe.

Virtues.——This balſam is uſed to ſoften the gums of little children, by rubbing them often with it; whereby they cut their teeth eaſy.

To extract the juice of craw-fiſh, you muſt bruiſe five or ſix of them in a marble mortar, humecting them with water of borage, and carrying them afterwards to the preſs.

Balſamum Balſaminæ. ℞ *Florum, foliorum, & fructuum balſaminæ,* ℥ iv. *Radicum conſolidæ majoris, ophyogloſſi, ariſtolochiæ rotundæ, valerianæ majoris, ana* ℥ ij. *Viſci in folliculis, ulmi reperti, ſucci cancrorum fluviatilium, foliorum pervincæ & ſaniculæ, ſummitatum floridarum hyperici, galli lutei, ana* ℥ j ſs. *Olei olivarum* lb iv.

Bruiſe the leaves, flowers, and miſletoe of elm, and put them together in a glazed earthen pot, pouring over them the oil, and the juice of craw-fiſh; cover the pot and place it in the ſun, where the matter muſt be left 12 days in digeſtion; boiling afterwards the infuſion over a ſlow fire to the conſumption of the wine; ſtraining the decoction by expreſſion; and after the oil has been left to ſettle, you muſt pour it by inclination to ſeparate it from its fæces; and then mix with it half a pound of diſtilled oil of varniſh, to make a balſam, which is to be kept for uſe.

Virtues.——This balſam is thought excellent to ſtrengthen the nerves, for wounds, burns, the piles, and ſore breaſt.

Balſamum ſtypticum, A. Mynſicht. ℞. *Amplaſtri ſtyptici, A Mynſicht,* ℥ iv. *Olei vitellorum ovorum, q. ſ. fiat balſamum, cui adde oleorum nucis moſchatæ, caryophyllorum, ſalviæ, ana* ʒ.

You'll melt gently in an earthen diſh four ounces of the ſtyptick plaiſter of *A. Mynſicht*, mixing with it, about as much oil of eggs as is neceſſary to give it the conſiſtence of an unguent; and when cool, add to it the oils of nutmeg melted, of cloves, and of ſage, making of the whole a balſam to be kept for uſe.

Virtues.—This balſam ſtrengthens the ſtomach, and the abdomen, it helps digeſtion, ſtops vomiting, and hæmorrhages, by anointing the ſtomach, the abdomen, and other afflicted parts with it.

Balſamum ſulphuris ſimplex.—Take three ounces of flowers of ſulphur, put it in a matraſs, and pour over it eight ounces of ſpirit of turpentine, and having ſtopped the matraſs, and ſhaken it well, place it in digeſtion at a ſlow ſand-heat for five or ſix hours, or till the oil is grown red; then pour

out the tincture by inclination, and keep it: which tincture is the balſam of ſulphur.

Virtues.—This balſam is proper to cleanſe the ulcers of the lungs and of the breaſt, it helps reſpiration, and is given to aſthmaticks.—The *doſe* is from a drop to ſix.

Balſamum ſulphuris anniſatum.——Put an ounce and a half of flower of ſulphur in a matraſs, pour upon it half a pound of oil of anniſeed, ſtop the matraſs, and place it in a ſand-heat, where the matter muſt be left in digeſtion till the flower of ſulphur be almoſt entirely diſſolved, and the oil has acquired a red colour, which commonly happens in nine or ten hours; and after the balſam has been left to ſettle, it muſt be decanted to ſeparate it from its fæces.

Virtues.——This balſam is good for the ulcers of the breaſt, and of the lungs, for the aſthma, the indigeſtions of the ſtomach, and the windy colick.—The *doſe* is from three drops to twelve.

Balſamum Lucatelli. ℞ *Olei olivarum, terebinthinæ Venetæ in aqua roſarum ad albedinem, lotæ, ana* ℔ j. ſs. *Ceræ citrinæ,* ℔ j. *Santali rubri ſubtiliter pulverizati,* ℥ ij.

Put in a glazed earthen pot the oil of olives, and eight or nine ounces of canary-wine, place the pot in a boiling hot balneo mariæ, where having been left till the wine be entirely conſumed, ſtrain the oil afterwards, and having melted in it over the fire, the wax, and the turpentine, take the matter off the fire, and when almoſt cold, mix with it the red ſanders, reduced into a very ſubtle powder, to make a balſam which muſt be kept for uſe.

Virtues.—The *Lucatellus balſam* is deterſive, proper to conſolidate green wounds, and to ſtrengthen the nerves.

Balſamum anodynum vel podagricum, Georgi Batei. ℞ *Saponis,* ℥ j. *Camphoræ,* ʒ vj. *Opii,* ʒ ſs. *Croci,* ʒ j. *Spiritus vini rectificati,* ʒ xviij.

The ſoap muſt be raſped, the opium cut in ſmall pieces, the camphire bruiſed, and all the drugs put in a matraſs with the ſpirit of wine; ſtopping afterwards the veſſel, and placing it in digeſtion on the hot ſand, or at ſome other gentle heat, where it muſt be left ten days, ſhaking it from time to time, to facilitate the diſſolution of the ingredients; the ten days elapſed, the infuſion ſhall be ſtrained through a flannel, and kept: which colature is the *anodyne balſam.*

Virtues——This balſam appeaſes the moſt excruciating pains, being applied on the part with a piece of linen cloth dipped in it, and renewing it every four hours, till the pain be entirely ceaſed. It is uſed for the rheumatiſm and the gout; it is alſo taken inwardly from 30 to 50 drops in wine.

The principal quality of this balſam proceeds from the opium.

Balſamum antipodagricum, Phil. Mulleri. ℞ *Maſtiches, olibani, myrrhæ, bdellii, gummi ammoniaci, opoponacis, mumiæ, aa* ℥ ij. *Tartari,* ʒ j ſs. *Vitrioli,* ℔ j. *Mellis,* ℔ ij. *Aquæ vitæ,* ℔ iv.

The gums muſt be coarſely pounded together; and the tartar, and vitriol together, putting afterwards all the powders with the honey and brandy in a large glaſs or ſtone cucurbite, ſtopping the veſſel, and leaving it in digeſtion, in a warm place, for eight days ſucceſſively; which elapſed, the cucurbite is unſtopped, a capital and receiver adapted to it, the joints luted, and the liquor diſtilled by a graduate fire; keeping the liquor for uſe, which is the balſam for the gout.

Virtues.—This balſam is excellent for the pains of the gout, and of the rheumatiſm; a piece of flannel is dipped in it, and applied on the afflicted part.

Balſamum mirabile, Fulleri. ℞ *Thuris* ℥ ij. *Maſtiches, caryophyllorum, galangæ, macis, cubebarum, ana* ʒ ſs. *Ligni aloes* ʒ j.

All the drugs muſt be very well pounded, and having been mixed with the honey and turpentine, the whole mixture muſt be put in a cucurbite, pouring upon it ſpirit of wine to the height of two or three fingers, diſtilling the whole in balneo mariæ, till the liquor appears red; and continuing the fire to extract the balſam, which muſt be rectified.

Virtues.——This *balſam* is good to cure all ſorts of wounds, for old ulcers, cancers, fiſtula's, and the maladies of the eyes.——The *doſe* inwardly is from five drops to ten.

UNGUENTS.

The name of *unguent* derives from the Latin *ungere*, to anoint, and as we anoint with oils as well as *unguents*, the antients called *unguents* the aromatick oils the joints were rubbed with, and thoſe who ſold them were called *unguentarii*; but we underſtand at preſent by *unguents*, certain compoſitions of greaſe, oil, wax, powder, to which are moſt commonly given conſiſtences much like that of greaſe.

Liniment comes from the *Latin* word *linire*, to anoint gently; what we call in Latin *linimentum* or *litus*, is a mixture of *unguents*, or of wax and oil of a conſiſtence thicker than oil, but leſs thick than the *unguent*; it is commonly uſed to molify and ſoften, by rubbing the tendereſt parts, as the breaſt, &c. with it.

The *cerata*, borrow their name from the wax which enter their compoſition, called in Latin *cera*. Antiently the *cerata* had a more ſolid conſiſtence than the *unguent*, and ſofter than the plaiſter, but at preſent there is no rule obſerved with regard to that; for they are ſometimes made as ſoft as *unguents*.

guents, ſometimes more liquid, and ſometimes harder: they conſiſt of the ſame drugs the *unguents* are compoſed of; and we give ſometimes the name of *cerat* to compoſitions where there is no wax; and as there is ſo little difference between *unguents*, *liniments*, and *cerata*, I'll place them all three under the ſame article, and not without reaſon, ſince it is very well known that to give a conſiſtence to theſe three compoſitions, one borrows in part the matter of the *unguent*, which ſerves here as a medium, and that the oils are the common baſis of them all.

Unguentum roſatum. ℞ *Axungiæ porci recentis, purgatæ & ſæpius lotæ, roſarum pallidarum recentium contuſarum, ana* ℔ vj.

The hog's lard muſt be new, freed of all its ſkins, and waſhed ſeveral times in water; and ſix pounds thereof having been put into an earthen pot, with an equal weight of pale roſes newly gathered ſeparated from their calice, and pounded in a marble mortar, and both ingredients well mixed together, the pot is to be covered and placed in digeſtion at the ſun for ſeven days, ſtirring the matter from time to time with a wooden ſpatula; the ſeven days elapſed, the infuſion is put to boil for an hour or two over a ſmall fire, and afterwards ſtrained with a ſtrong expreſſion, putting into the colature as much roſes as before; and having left the matter in digeſtion for ſeven days more, it muſt be ſtrained by expreſſion, and the colature is the *unguent of roſes*, which muſt be kept for uſe. To make it red, add two ounces of the roots of orcanette ſteeped in the unguent while hot, for four or five hours.

Virtues.—The *unguent of roſes* is eſteemed proper to reſolve and ſoften; it is uſed for the hæmorrhoids, the inflammations, and the pains of the joints.

Moſt Diſpenſaries require red roſes for the compoſition of this *unguent*, but the Apothecaries wanting to render their *unguent* odorous, employ pale roſes, which have a much ſtronger and agreeable ſmell; they are beſides more reſolutive, and more capable to produce the effects expected from the *unguent of roſes*.

Unguentum album, ſeu de ceruſa. ℞ *Olei roſati*, ℔ ij. *Cereæ albæ*, ℔ ſs. *Ceruſæ Venetæ*, ℥ viij. *Camphoræ*, ℥ j.

The white wax muſt be broken into ſmall pieces, and melted in the oil of roſes at a ſlow fire, mixing with it afterwards with a wooden ſpatula, the ceruſs, which has been reduced before into a very ſubtile powder, and laſtly the camphire diſſolved in ſome oil of roſes, ſtirring the *unguent* till the ingredients be very well incorporated together, and keeping the *unguent* for uſe.

Virtues.—This *unguent* is proper to dry, and cure burns, for the itch, the itching of the ſkin, and ſlight wounds.

The Apothecaries employ moſt commonly oil, and often a ſtinking ſort, in the preparation of this *unguent*, which renders the ſmell thereof very offenſive.

Unguentum mundificativum, Nic. l'Emery. ℞ *Axungiæ porci, terebinthinæ, ana* ℥ viij. *Butyri recentis, olei hyperici, unguenti populei, ana* ℥ iv. *Olei laurini, viridis æris, ana* ℥ iij. *Vitrioli albi*, ℥ iv. *Boracis, realgal, aut arſenici rubri, ana* ℥ ij.

Pound and mix together the verdigreaſe, white vitriol, borax, and realgal; melt together over a ſmall fire, in a baſon, the hog's lard, freſh butter, and populeum; add to it, when off the fire, the turpentine and oil; and when the mixture is almoſt cold, mix exactly with it the powders, ſtirring the whole mixture for ſome time with a wooden ſpatula; and keep the unguent for uſe.

Virtues.—This unguent is a powerful deterſive; it dries the wounds, conſumes the ſlimy fleſh, and reſiſts the gangrene: it may be applied with pledgets on old ulcers, and ſcrophulous tumours, when open.

Unguentum Neapolitanum ſimplex. ℞ *Argenti vivi* ℥ vi. ſs. *Terebinthinæ Venetæ* ℥ iv. *Axungiæ ſuillæ* ℔ iv.

The quickſilver muſt be ſtired hard with the turpentine for ſix hours, in a large braſs mortar, till it be entirely extinguiſhed, mixing with it by degrees afterwards, the hog's lard to make an *unguent* to be kept for uſe.

Virtues——This unguent is proper for the itch, ringworms, and other itching of the ſkin: it kills the lice, fleas, bugs, and crab lice, by anointing the parts of the body with it, forbearing to anoint the breaſt and ſtomach, where it could cauſe ſome alteration, becauſe of the quickſilver which enters into it. The bedſteads are rubbed with it to kill the bugs.

This preparation of *unguent* is too weak to excite a ſalivation; though it is proper to examine the conſtitution of thoſe, on whom it is employ'd; for if they are weak and eaſy to be moved, it could excite in them a ſlight one. To each ounce of *unguent* there is a drachm of quickſilver.

A *Pomatum for the itch.*——Mix together four ounces of hog's lard, waſhed ſeveral times, and half an ounce of white precipitate of mercury, for a pomatum.

Unguentum Neapolitanum quadruplicatum mercurio. ℞ *Axungiæ ſuillæ* ℔ ij. *Argenti vivi* ℥ iv. *Terebinthinæ claræ* ℥ iv. *Olei laurini* ℥ ij. *de ſpica, ſtyracis liquidæ ana* ℥ j.

The quickſilver muſt be ſtirred hard in a large braſs mortar with the turpentine, the liquid ſtorax,

and

and the oils for ten or twelve hours, or till it be entirely extinguiſhed, and mixing afterwards by degrees the greaſe with it, for an *unguent* to be kept for uſe

Virtues.——This *unguent* is proper to excite ſalivation, and to cure the pox, by anointing gradually the feet, the legs, thighs, lower abdomen, back bone, neck, arms, and hands, as explained at large in the articles of *Chymiſtry* and *Surgery*.

Unguentum enulatum. ℞ *Radicis enulæ campanæ* ℔ ſs. *Argenti vivi, terebinthinæ claræ, olei abſinthii, ana* ℥ iij. *Axungiæ ſuillæ* ℔ ij. *fiat unguentum*, S. A.

Virtues.—This *unguent* is proper for the itch, ringworms, and for other itchings of the ſkin.

Unguentum contra vermes. ℞ *Olei abſinthii* ℔ ſs. *Succorum foliorum perſicorum, tanaceti, ana* ℥ j. *Ceræ* ℥ j ſs. *Aloes* ℥ ij. ſs. *Centaurii minoris, corallinæ, ſeminis contra vermes, ana* ℥ j. ſs. *f. unguentum*, S. A.

Virtues.——This *unguent* is proper to kill the worms, by anointing the navel with it.

If a drachm of mercurius dulcis was added to this compoſition, the *unguent* would ſtill be more efficacious.

Unguentum de rapis pro pernionibus. ℞ *Olei raparum* ℥ iv. *Reſinæ pini, ceræ flavæ, terebinthinæ, pinguedinis arietis, ana* ℥ j.

You'll put to melt together over a moderate fire, in the oil of radiſhes, or turnip-ſeeds, extracted by expreſſion, the turpentine, mutton-fat, and roſin, ſtirring the matter till cold; which is the *ungent of radiſh.*

Virtues.—This unguent is proper for chilbains. The oil of hen-bane is better for chilbains than that of radiſh.

Unguentum anodinum ad hemorrhoides. ℞ *Oleorum roſati & violati, ana* ℥ iij. *Ceræ* ℥ j ſs. *Amyli, lythargyri præparati, tragacanthi, ana* ʒ iij. *Caphuræ, opii, ana* ℈ ij. *Albumina ovorum*, No. ij.

The litharge and ſtarch muſt be pounded together, the gum tragacanth by itſelf in a mortar warm; the opium bruiſed in a mortar, and pulverizing it with a little of the other powder, melting afterwards the wax cut in ſmall pieces, in the oil, and mixing the powders with it off the fire; and the unguent being cold, the whites of eggs, and the camphire diſſolved in a little oil of roſes muſt be incorporated with it, to make of the whole an *unguent* to be kept for uſe.

Virtues.——This *unguent* is proper to ſoften and dry, it appeaſes the pains, and temperates the inflammations; it is applied on the hæmorrhoides.

Unguent for burns of A. Mynſicht.——Take two ounces of whites of eggs, and an ounce of oil of olives; mix the whites of new-laid eggs, and the oil in an earthen diſh, ſtir them well together with a wooden ſpatula, till they be well mixed, and are formed into an unguent or nutritum.

Virtues.—This *unguent* is excellent for burns; the Author orders to anoint the burnt part with it ſeveral times a day, without applying any cloth over it, till the cruſt formed on the top falls of itſelf.

Another *Unguent for burns.*——Crumble four ounces of horſe-dung newly voided, and mix with it one pound of hog's lard in a frying pan; fry that mixture over a moderate fire about a quarter of an hour, ſtirring the matter all the while with a ſpatula, and ſtraining it afterwards while hot, by a ſtrong expreſſion; the colature is the *unguent.*

Virtues.—This *unguent* is excellent for all ſorts of burns, by applying it upon them with a piece of brown paper.

Unguentum ad facilitandum partum. ℞ *Axungiæ gallinæ,* ℥ vj. *Porci,* ℥ ij. *Butyri recentis, olei irini, ana* ℥ j. *Trochiſcorum de myrrha,* ℥ ſs. *Radicis Ariſtolochiæ rotundæ,* ʒ ij. *Cinnamoni, ſtyracis, ana* ʒ j.

The oil, greaſe, and butter, muſt be liquified together over a little fire; mixing afterwards in it the other drugs reduced into a ſubtile powder, ſtirring the mixture with a wooden ſpatula, till the unguent be cold.

Virtues.—This unguent is proper to facilitate a delivery, and to expel the after-birth, by anointing the lower belly with it, in the region of the abdomen, and in the vagina, when the woman is in labour.

Unguentum de terebinthina. ℞ *Terebinthinæ claræ,* ℥ j. *Maſtiches, myrrhæ, olibani, ana* ℥ ſs. *Vitellos ovorum*, No. iij.

The myrrh, olibanum, and maſtich, muſt be well pounded together, and mixed afterwards with the turpentine, and having added to it the whites of eggs, the mixture muſt be ſtirred with a wooden ſpatula, and the unguent, which is digeſtive, kept for uſe.

Virtues.—This unguent diſpoſes the matters for ſuppuration; it is applied in wounds, newly made, on pledgets, and tents are anointed with it.

An unguent to make the hairs grow.—Take four ounces of bear's greaſe; an ounce and half of laudanum; an ounce of honey; of dried abrotanum, and balſam of *Peru*, of each ſix drachms; three drachms of dried roots of ruſhes, and two drachms of the oil of nutmegs; pound together the roots of ruſhes, and the abrotanum; and the laudanum by itſelf; melt together the bear's greaſe, balſam of *Peru*, and the oil of nutmegs, by a ſlow fire, then mix the powders with it, and laſtly the honey, to make an unguent.

Virtues.—This unguent is proper to make the hairs grow, either by anointing the head with it or the teeth of the comb.

Liniments.

A *liniment for the piles.*—Take of the pulp of millepedes, unguentum populeum, oil of eggs, of each an ounce; and half a drachm of extract of opium.

You'll pound the millepedes alive, in a marble or ſtone mortar, and ſtrain them afterwards through a ſieve turned upſide down, to extract the pulp thereof; then you'll mix this pulp with the unguent populeum, and the oil of eggs, ſtirring the whole mixture a long while together in a mortar, to make a liniment.

Virtues.—This liniment is proper to appeaſe the pains of the piles, being applied upon them.

Another *liniment for the piles.*——Take two drachms of flower of ſulphur, half an ounce of oil of eggs, and an ounce of oil of roſes; mix theſe drugs together for a liniment, which muſt be applied on the piles.

Aliud linimentum. ℞ *Salis ſaturni,* ℥ ſs. *Oleorum chamomillæ & roſati, ſucci umbilici veneris, ana* ℥ ij. *fiat ex arte linimentum ad formam nutriti.*

Linimentum aliud. ℞ *Olei lini, pulpæ cepæ ſub cineribus coctæ, ana* ℥ ij. *Ceræ albæ,* ℥ ſs. *Miſce & fiat ex arte linimentum.*

All theſe different liniments are very proper to appeaſe the pains of the piles.

A *linament to hinder the face from being ſcarred by the ſmall-pox.*——Take ceruſs, and prepared litharge of gold, of each a drachm; the oils of the four large cold ſeeds, of ſweet almonds, and of eggs, of each half an ounce.

Put in a braſs mortar the litharge and ceruſs, and mix with it by degrees the oils, and about ſix drachms of the waters of plantain and of ſolanum, nouriſhing and agitating the matter, to make of it a nutritum, which muſt be kept for uſe.

Virtues.—This liniment is proper to take off the cicatrices, and fill up the pits left by the ſmall-pox on the ſkin; by anointing the face, neck, and hands with it, when the ſmall-pox begins to dry.

Cerats.

A *Cerat* ſhould never be made but in a ſmall quantity; ſince, as it grows old, it loſes its virtue.

Ceratum polychreſtum. ℞ *Olei olivarum,* ℔ j. *Lithargiri ſubtiliſſimè pulverizati,* ℥ iv. ſs. *Ceræ novæ,* ℥ j. ſs. *Terebenthinæ claræ, thuris, ana* ℥ j. *Gummi ammoniaci, bdellii, ana* ℥ vj. *Galbani, opoponacis, ana* ℥ ſs. *Myrrhæ, lapidis calaminaris, ariſtolochiæ longæ & rotundæ, ana* ℥ ij.

The ariſtoloches having been pounded together; the myrrh, bdellium, frankincenſe, galbanum, and opoponax together; and the litharge, and lapis calaminaris, together; put theſe two drugs to boil together in a ſufficient quantity of water, ſtirring continually the water with a wooden ſpatula, till it has acquired the conſiſtence of unguent, mixing then with it the gums reduced into powder, and the wax, which will melt in it in a very ſhort time; then take the veſſel off the fire, and when the cerat will be half cold, mix exactly with it the turpentine, and the powders of ariſtoloche, to make a cerat, which is to be kept for uſe.

Virtues.——This cerat is emollient, digeſtive, ſuppurative, and employ'd to cicatriſe wounds.—It is called *polycreſt*, becauſe it can ſerve for ſeveral uſes.

Ceratum barbarum, Galeni. ℞ *Terebenthinæ, ceræ, reſinæ pini, bituminis judaici, ana* ℔ ſs. *Olei,* lb. viij. *Lithargyri,* ℥ v. *Ceruſæ, æruginis, ana* ℥ ij. ſs. *Opoponacis,* ℥ j. ſs

The pitches and wax muſt be melted in the oil; and the bitumen judaicum, the litharge, ceruſs, verdigreaſe, and opoponax, having been reduced into a ſubtle powder, they ſhall be mixed in the melted matter in proportion as it grows cold, to make a cerat, which muſt be kept for uſe.

Virtues.—This cerat is very proper for what is called green wounds, for the ſcirrhe's, and the gout; it is deterſive, emollient, reſolutive, and cicatriſes wounds.

Ceratum diapyritis, Galeni, reformatum. ℞ *Olei veteris,* ℔ ij. *Ceræ citrinæ,* ℥ iij. ſs. *Terebinthinæ, pyritis præparati, ana* ℥ iij. ℥ j. *Bituminis judaici, lithargyri, ana* ℥ ij. ſs. *Aluminis,* ℥ xv. *Reſinæ, gummi ammoniaci, ana* ℥ j. ſs. *Galbani, aloes, ana* ℥ j. *Æruginis æris, thuris, ana* ℥ v. *fiat ceratum, S. A.*

Virtues.——This cerat is proper for inveterate ulcers, and fiſtula's, it is deterſive, emollient, and reſolutive.

Plaisters.

The antient *Greeks* called plaiſters *emplaſta*, of the *Greek* verb ἐμπλάσσω, which ſignifies to form in a maſs, to wrap, to ſtop; but the modern *Greeks* have pronounced *emplaſtra*, and the *Latins* have followed them.

Plaiſter is the moſt ſolid compoſition of all thoſe which are applied outwardly; it was invented of that conſiſtence, that remaining longer faſtened on the parts of the body, the remedies it is compoſed of ſhould have time enough to produce their effects. The drugs uſed to give a body or conſiſtence to *plaiſters*, are moſt commonly *wax, roſin, pitch, gum, greaſe, litharge*, and other preparations of lead; which being ſulphurous, is eaſily diſſolved in boiling with the greaſe and oils, which are ſulphurs, and gives them a hard conſiſtence.

Emplaſtrum

Emplaſtrum diachylon album, ſeu ſimplex. ℞ *Olei communis* ℔ iij. *Lithargyri auri præparati* ℔ j ſs. *Mucilaginum radicis althææ, fœnugreci, & lini, ana* ℔ j.

Three ounces of roots of marſh-mallows newly gathered muſt be cut in ſmall pieces, and put in a glazed earthen pot with two ounces of fœnugreek and lin-ſeeds, and having poured upon thoſe ingredients ſix or ſeven pounds of hot water, the matter muſt be left in digeſtion till the next day, and then put to boil gently, till the liquor becomes thick and mucilaginous, is ſtrained by expreſſion, and mixed afterwards with the oil and litharge in a baſon, and the baſon placed over a pretty ſtrong fire, where the matter muſt boil, ſtirring it continually with a wooden ſpatula, till it has acquired the hardneſs of plaiſter, and the whole watery humidity be conſumed, which will be known at the matter having done boiling; you'll take then the baſon off the fire, and continue ſtirring till it be half cold, and fit therefore to be formed into magdaleons.

Virtues.——This *plaiſter* is proper to ſoften, to digeſt, ripen and reſolve.

Emplaſtrum diachylon de gummis. ℞ *Meſſæ diachyli ſimplicis,* ℔ iv. *Gummi ammoniaci, galbani, bdellii, & ſagapeni, ana* ℥ j.

The common method is to diſſolve the gums in wine, or vinegar, over a moderate fire, to ſtrain the diſſolution, and thicken the colature about the ſame ſize, to the conſiſtence of plaiſter; but as by that manner of operating the moſt eſſential of the gums is evaporated, I would adviſe to endeavour, as much as poſſible, to reduce the gums into powder; which may be done, if after they have been well choſen, they are put to dry in the ſun, or at a ſlow fire, before they are put in the mortar.

The preparation of this plaiſter is eaſy, in whatever manner the gums be prepared; for nothing elſe is to be done, but to melt the diachylon over a moderate fire, and mix the gums with it; if the gums have been diſſolved, they muſt be put to melt with the plaiſters; but if they be in powder, they are not to be be mixed till the plaiſter is half cold, to avoid its being lumpy.

Virtues.—The *diachylon of the gums* is the moſt powerful of all diachylons, to digeſt, ripen, and reſolve.

Emplaſtrum de meliloto reformatum. ℞ *Florum meliloti ſiccatorum* ℥ iij. *Radicis iridis, ſeminis fœnugræci, foliorum abſinthii ſiccatorum, gummi ammoniaci, myrrhæ, ana* ℥ j. *Radicum cyperi, althææ, nardi celticæ, baccarum lauri, florum chamomillæ, croci, ana* ℥ ſs. *Ceræ citrinæ, reſinæ, picis albæ, ſevi hircini, ana* lb. j. *Terebinthinæ claræ* ℥ ix.

The flowers, herbs, roots, ſeeds and berries, muſt be pounded together, the ſaffron by itſelf, after it has been dried between two papers; and the gum ammoniack and myrrh together; mixing afterwards, all theſe powders together, and putting to melt in a baſon, over a little fire, the wax; roſin, pitch, the fat of rams, with the turpentine, and having ſtrained the matter through a cloth, you'll mix the powders in it, when half cold, to make a plaiſter, which muſt be formed into magdaleons.

Virtues,——This plaiſter is emollient, reſolutive, and expels wind.

Emplaſtrum de minio ſimplex. ℞ *Minii* lb j ſs. *Olei roſarum* lb iij. *Aquæ communis q. ſ.*

The minium muſt be well pounded, and mixed afterwards in a baſon with the oil, and about two pints of water, making the mixture to boil very faſt over the fire, and ſtirring it continually with a wooden ſpatula, till it has acquired the conſiſtence of a plaiſter; and if there was not water enough to finiſh the coction, more ſhould be added to it.

Virtues.—The plaiſter of minium is deſiccative, and proper to cicatriſe wounds.

Some mix eight ounces of yellow wax in this plaiſter, and uſe it then to expel the milk from the breaſts, by applying it upon them.

Emplaſtrum cephalicum, aut pro commiſſura, aut ſtephanæon. ℞ *Gummi hederæ, tacamahacæ, ſtyracis, benzoini, maſtiches, olibani, labdani, ana* ℥ ij. *Cinnamomi, terebenthinæ venetæ, ana* ℥ j. *Caryophyllorum, & nucis moſchatæ, ana* ℥ ſs.

The gums and laudanum muſt be pounded together, the cloves and nutmeg together, and the cinnamon by itſelf, putting afterwards all thoſe powders together in a braſs mortar, and incorporating them with the turpentine, and with liquid ſtorax, enough to give to the mixture a conſiſtence of plaiſter; ſtirring that mixture a long while to mix and incorporate well the ingredients together.

Virtues.—This plaiſter is excellent to ſtrengthen the brain, to rarefy and diſſipate the too coarſe pituita; it is uſed in the epilepſy and lethargy, being applied on the coronal ſuture.

Emplaſtrum regium ad herniam. ℞ *Picis navalis,* j. lb. *Ceræ flavæ, terebinthinæ claræ, ana* ℥ iv, *Radicis conſolidæ majoris ſiccæ, maſtiches, ana* ℥ ij. *Labdani,* ℥ j. ſs. *Hypociſtidos, terræ ſigillatæ, ana* ℥ ſs. *Nuces cupreſſi,* No. xij. *Fiat emplaſtrum. S. A.*

Virtues.—This plaiſter is excellent for the ruptures, it ſtrengthens the peritoneum, after the inteſtine has been reduced into its place, by applying it on the place of the relaxation, keeping it firm by means of a bandage, and renewing it every tenth day.

Emplaſtrum de ſpermate ceti. A. Mynſicht. ℞

Ceræ albæ, ℥ iv. *Spermatis ceti*, ℥ ij. *Galbani in aceto diſſoluti, trajecti, & coſti*, ℥ j.

The white wax cut in ſmall pieces, with the purified galbanum, muſt be melted in a glazed earthen porringer, over a little fire, mixing with it afterwards the ſperma ceti, to make a plaiſter, which muſt be kept for uſe.

Virtues.—The plaiſter of ſperma ceti appeaſes the fury of the milk of women newly deliver'd, it hinders it from knotting in the breaſts, and diſſolves it when knotted, it is alſo emollient, and reſolves the ſcrophulous tumours.

Emplaſtrum ſtipticum crollii reformatum. ℞ *Litharyri præparati*, lb j. ſs. *Lapidis calaminaris*, lb ſs. *Oleorum lini, olivarum, ana* lb j. ſs. *Laurini*, lb j. *Decocti radicis ariſtolochiæ, q. ſ. Coquantur ex arte ad emplaſtri ſpiſſitudinem, deinde adde, ceræ flavæ, colophoniæ, ana* lb j. *Terebinthinæ, vernicis, ana* lb ſs. *Opoponacis, ſagapeni, galbani, bdellii, ammoniaci, ana* ℥ iij. *Lapidis hæmatitis* ℥ ij. ſs. *Olibani, myrrhæ, aloes, ſuccini, ariſtolochiæ longæ, & rotundæ, ana* ℥ j. ſs. *Mumiæ, ſanguinis draconis, terræ ſigillatæ, vitrioli albi, camphoræ, ana* ℥ j. *Florum antimonii*, ℥ ſs. *Fiat emplaſtrum, S. A.*

As the camphire is very volatile, it muſt not be mixed till the plaiſter is almoſt cold.

Virtues.—This plaiſter is proper for wounds made with a ſmall ſword, for prickings, and bites, and for all other wounds and ulcers; it digeſts, ripens, mundifies, cicatriſes, and reſolves; it ſtrengthens the nerves, and reſiſts the malignity.

Emplaſtrum baſilicum majus. ℞ *Ceræ albæ, reſinæ pini, ſevi vaccini, picis nigræ, & burgundiæ, terebinthinæ, thuris, myrrhæ, ana* ℥ j. *Olei communis, q. ſ.*

The myrrh muſt be reduced into a ſubtile powder, and having put all the other drugs to melt with about an ounce of common oil, the melted matter muſt be ſtrained, and the myrrh mixed with the colature to make a plaiſter, which muſt be kept for uſe.

Virtues.—This plaiſter helps ſuppuration, agglutinates wounds and cures them.

Emplaſtrum quatuor gummium. ℞ *Gummi ammoniaci, ſagapeni, galbani, opoponacis, ana* lb. *Colophoniæ* lb ſs.

The gums muſt be diſſolved in vinegar over a little fire, the diſſolution ſtrained through a flannel with a hard expreſſion, and put to thicken to a ſolid conſiſtence; mixing afterwards with it the colophon, to make a plaiſter which muſt be kept for uſe.

Virtues.—This plaiſter is emollient, ſuppurative, and reſolutive.

Emplaſtrum ad ganglia M. Charas. ℞ *Gummi ammoniaci, galbani, opoponacis, ſagapeni, myrrhæ electæ, ana* ℥ iij. *Olei laurini* ℥ j. *Sulphuris vivi, vitrioli Romani, ſalis ammoniaci, ana* ℥ ſs. *Euphorbii* ℥ ij.

The gums ammoniack, galbanum, opoponax, and ſagapenum, muſt be diſſolved in vinegar, and the diſſolution having been ſtrained by a hard expreſſion, the humidity thereof muſt be evaporated, till it be reduced to the conſiſtence of plaiſter; mean while you'll pound together the myrrh and euphorbium, the ſulphur by itſelf; and the Roman vitriol and ſal ammoniack together, mixing afterwards all thoſe powders, incorporating with the gums liquified over a very ſlow fire the oil of bays, and afterwards the powders, ſtirring a long while the mixture, and the plaiſter will be done.

Virtues.—This plaiſter is penetrating, attenuating, emollient, and reſolutive, proper for the ſcrophulous tumours, wens, ſkirts of the liver, and of the ſpleen, and for the king's-evil,

In theſe *recipes* or *preſcriptions* the reader meets with ſeveral terms proper to the practitioners in this art; which require ſome explanation. Such are the *names* and *characters* of their *weights* and *meaſures*: and thoſe inſtruments and veſſels made uſe of by the Apothecary, with which I ſhall conclude this treatiſe.

The WEIGHTS uſed in *medicine*, are, the pound, half-pound, quarter of a pound, ounce, drachm, ſcruple, and grain.

The POUND, in medicine, is of twelve ounces, deſigned by this character lb j.—The half-pound by this lb ſs.—And the pound and half by this lb j. ſs.

The QUARTER *of a pound* is of three ounces; formerly deſigned by this character 4 tar j. which is at preſent out of uſe, ſince we mark a quarter of a pound by ounces, thus ℥ iij.

The OUNCE in medicine, is the twelfth part of a *pound*, marked thus ℥ j. The half ounce thus, ℥ ſs. and the ounce and half thus, ℥ j ſs. which ounce is compoſed of eight drachms.

The DRACHM, which is the eighth part of an ounce, is deſigned by this character ʒ, which is as a ℥ in Arithmetick, becauſe it is compoſed of three ſcruples: the *half-drachm* is marked thus ʒ ſs. and the *drachm and half* thus, ʒ j ſs.

The SCRUPLE is the third part of a *drachm*, deſigned by this character ℈ j. and is compoſed of twenty four grains: the *half ſcruple* is marked thus ℈ ſs. and the *ſcruple and half* thus ℈ j ſs.

The GRAIN is the twenty fourth part of the *ſcruple*, deſigned by *gr.* j. or *gn.* i.

The MEASURES for liquids here, in *England*, are

are the *pint*, conſiſting of *twelve ounces*; the *half-pint*, conſiſting of *ſix ounces*; the *quartern* of *three ounces*; and *half-quartern*, of an *ounce and half*, which are moſt commonly marked in the preſcriptions by pound, thus lb j. for a *pint*: *half a pound*, thus lb ſs. for *half a pint*: a *pound and half*, thus lb j ſs. for a *pint and half*: three ounces, thus ℥ iij. for a *quartern*; an *ounce and half*, thus ℥ j. ſs. for a *half-quartern*. And laſtly, *a drachm*, thus ʒ j. or *half a drachm*, thus ʒ ſs.

The *meaſures* for dry ingredients, *viz.* wood, herbs, fruits, and ſeeds, are known by the name of the bundle, the handful, and the pinch.

The BUNDLE is, what an arm folded roundwiſe can contain, marked thus *faſc.* j.

The HANDFUL is as much, as a hand can hold, deſigned by *man.* j. or M. j.

The PINCH is, as much, as two fingers and the thumb can hold, deſigned thus *pug.* j. or thus *p.* j.

The *meaſure* of fruits and of ſeveral animals, is made by *number*, deſigned thus *No.* or by *pairs*, deſcribed thus *par.*

When we find in preſcriptions *ana*, or *aa*, we muſt underſtand of each, or as much of one as of the other.

By *q. ſ.* muſt be underſtood a ſufficient quantity, or as much as is neceſſary.

By *ſ. a.* or *ex arte*, muſt be underſtood according to the rules of art.

By *B. M.* muſt be underſtood *balneum mariæ*.

By *B. V.* muſt be underſtood *balneum vaporis*, or vaporous bath.

The VESSELS uſed for the *coctions* of the *compoſitions* in *medicine*, are copper baſons, ſimple or tinned, large cauldrons, frying pans, ſkillets, iron pots, copper pots tinned, pewter baſons, earthen or ſtone pans, earthen diſhes, earthen porringers, earthen pots, glaſs, and ſtone cucurbites, copper cucurbites tinned inſide, with their refrigeratories, crucibles, *&c.*—One muſt as much as poſſible employ earthen or glaſs veſſels for the preparations, which are to be taken inwardly; becauſe neither earth nor glaſs communicates any impreſſion to the drugs, and copper will do it; but as glaſs and earthen veſſels are moſt commonly ſmall, and break eaſily at the fire; and the earthen ones are very often penetrated by the liquors, one may uſe copper veſſels tinned, without any fear that the metal will communicate itſelf to the drugs, becauſe tin does not rarefy itſelf ſo eaſily as copper.

The *veſſels*, employed for the infuſions, and to keep the *galenical compoſitions*, are pots of gold, ſilver, pewter, lead, earth, ſtone, glazed earthen ware, glaſs, cryſtal, bottles, jugs, and boxes.

Gold, ſilver and pewter are the moſt proper metals for the fabrication of the veſſels which are to ſerve for the infuſions, and to preſerve the remedies; but as they can be penetrated by ſeveral ſalts, and moſt of the ſpirits of the mixtures, they may communicate ſome ſlight impreſſion to the veſſels put in them, therefore I would preſer glaſs and earthen-ware in that occaſion to thoſe metals; tho' ſtone is the moſt proper material for thoſe veſſels.

Muſk is preſerved in *leaden boxes*, that being cooler in that metal than any where elſe, leſs of its parts may be diſſipated. Several uſe lead preferable to others, to preſerve treacle, orvietan, and mithridate, becauſe thoſe compoſitions retain better their conſiſtence in leaden pots, or boxes, than in thoſe of any other matter: though it is to be feared the particles of the lead mixing with thoſe compoſitions ſhould alter their quality.

The boxes uſed to keep the ſimple drugs, as the ſenna, agarick, and rhubarb, ſhould be made of wood leſs ſubject to worms.

The INSTRUMENTS uſed in *medicine*, are *mortars* of bell-metal, with their peſtles proportioned to them; mortars of braſs, pewter, lead, and glaſs, with their peſtles of the ſame matter: mortars of marble and ſtone, with their wooden peſtles: *porphyries* with their *mullers*, *funnels*; *ſyringes*, *ſpatulas*, *biſtorters*, *raſps*, *ſpoons*, &c.

The *mortars* of *bell-metal* are great and ſmall; the great ſerve to make almoſt all the powders, to malax the maſſes of pills and troches, and to extinguiſh the quickſilver; their peſtles are of iron.

The *ſmall mortars* of the ſame matter ſerve to reduce into powder a ſmall quantity of drugs eaſily pounded, and to diſſolve the compoſitions, which are to enter potions, clyſters, colyres, and injections.

The *leaden-mortars* are uſed to make the unguent *nutritum*, the butter of *ſaturn*, the deſiccative liniments, where it is wanted that the metal ſhould communicate its impreſſion.

Iron mortars are great and ſmall; the great ones ſerve to reduce into powder ſeveral ingredients, which enter the remedies applied outwardly; the ſmall ones are employed to receive the matters in fuſion, which are thrown into them, *&c.*

The *mortars* of *marble* are great and ſmall; and great ones ſerve to pound the almonds, nuts, ſeed, *&c.* the oils thereof are to be extracted by expreſſion; to bruiſe the plants, the juice thereof is alſo to be extracted. The ſmall ones ſerve to pound the almonds, and the cold ſeeds to make the emulſions.

The *ſtone mortars*, very clean can ſerve inſtead of the marble ones, but they are ſeldom employed but for the corroſive powders; as to pound red precipitate, to mix crude mercury with corroſive ſublimate, to make the mercurius dulcis; mortars of marble and glaſs can ſerve for the ſame uſes.

The *porphyries* and *ſea-ſhells* are uſed to reduce into an impalpable powder the hardeſt drugs, as,

the

the precious ſtones, the coral, pearls and tutty. They are ground with a muller, which is a little block of porphyry, or other hard ſtone, poliſhed underneath; round, or of a figure to be laid hold on eaſily.

The *funnels* are of copper, tin, earthen ware, ſtone, and glaſs: they ſerve to put the liquors into the bottles, and to ſupport the filtration. Thoſe of glaſs or of ſtone, are preferable to them, either in *Chymiſtry*, or in the *Galenical Pharmacy*.

The *Syringes* are of ſilver, of pewter, or of copper: they are great and ſmall; the great muſt contain a pound of liquor, they ſerve for the clyſters: the ſmall ones muſt contain two or three ounces of liquor; they ſerve for the injections made in the penis, in the matrice, and in wounds.

The *Spatula's* are either of ſilver, or pewter, iron, ſteel, ivory, guaiac, box, or of common wood.

The *Spatula's* of *ſilver* are better than thoſe of any other metal, becauſe they are not ſubject to ruſt; they are uſed for the cordial confections.

The *ſpatulas* of *pewter* can ſupply the want of thoſe of ſilver.

The *ſpatulas* of *ſteel* are preferable to thoſe of iron.

The *ſpatulas* of *ivory* are very proper for the confections: thoſe of *guaiac*, of *box*, and of *common wood*, ſerve to ſtir the herbs, and other ingredients, which enter the infuſions and decoctions.

The *biſtorters* are rollers of *wood*, which ſerve to mix the remedies, and to ſpread the lozenges.

The *raſps* are of *tin* faſten'd on wood; they are uſed to raſp the agarick, which is to be reduced in powder, and to raſp the fruits and roots, the juice whereof is to be extracted.

The *ſpoons* are of gold, ſilver, iron, wood, mother of pearl, ivory, and tortoiſe ſhell.

The *ſpoons* of gold are rare in an Apothecary's ſhop, becauſe of their great value; thoſe of ſilver ſupply their want. The large ſpoons and ſkimmers are commonly of pewter or tin, but thoſe that love neatneſs have them of ſilver.

The *wooden ſpoons* can ſerve for the extraction of pulps.

The *ſpoons* of *mother of pearl*, of *ivory*, and of *tortoiſe-ſhell*, are proper to adminiſter ſyrups, potions, or other liquors to the patients.

The *preſſes* are of different figures; their matter is always of a ſtrong and compact wood.

The *diſpenſaries* are a kind of flat and ſquare boxes, without lids, made in the faſhion of drawers: they ſerve to contain the ingredients which enter a compoſition well prepared, and diſpos'd in order.

METALS.

METALS are hard and ſolid bodies, fuſible by fire, and ductile by the hammer. We commonly diſtinguiſh ſix or ſeven ſorts of *metals*, viz. *Gold*, *ſilver*, *copper*, *tin*, *iron*, *lead*, and *quick-ſilver*: Where we muſt obſerve, that the antients underſtood by the name of *tin*, a certain mixture of ſilver and lead; but what we call tin, at preſent, was by them called white or candied lead.

I have ſaid, that we reckon ſix or ſeven ſorts of *metals*; for *mercury* or *quick-ſilver*, is pretended to be rather a metallick matter, or the ſeed and principle of *metals*, than a *metal*; for it is neither diſſolvable by fire, malleable, nor fix'd: in effect, it ſeems to conſtitute a peculiar claſs of foſſils.

As to the origin and formation of *metals*, various are the ſentiments of philoſophers antient and modern. M. *Tournefort* is of opinion, that *metals* as well as all other minerals, have their origin from ſeeds, like plants; that they have veſſels with juices circulating in them, *&c.*

Plato will have the cauſe of *metals* to be a humid vapour incloſed in the bowels of the earth, which being variouſly intermixed with parts of the earth produces various *metals*. *Plotin* maintains ſulphur to be the father of *metals*, and an oleaginous viſcous humour the mother. *Lidgat* endeavours to prove all *metals*, generated by a ſubterraneous fire; urging among other reaſons, that many *metals* when taken out of the earth, are exceedingly hot. *Du Hamel* ſhews, that *metals* do not take their riſe either from any vaporous exhalation, or from water, or from earth, but are generated of mercury, ſulphur, and ſalt. He adds, that *metals* take their matter and weight from the mercury, and their tincture and form from ſulphur.

Some authors own the firſt rudiment of a metal to be a ſaline ſubſtance ſwimming in water, which is by little and little carried off. By how much the terreſtrial parts are more exquiſitely mixed with the aqueous or humid, by ſo much is the *metal* more heavy and firm, as having fewer and ſmaller pores.

Dr. *Woodward* maintains, that all *metals* now found in the ſtrata of the earth, owe their preſent condition to the deluge, whence he alſo imagines, the ſtrata of ſtone, earth, marble, *&c.* were formed.

The ſame author complains of the great uncertainty and inconſtancy in the mineral and metallick kingdom; neither colour, figure, nor ſituation in the earth, being to be depended on, ſo as to make any poſitive judgment from them.

M. *Tournefort*'s opinion is, that *metals* have their origin from ſeeds like plants, and have their veſſels

veſſels with juices circulating thro' them. But there is nothing concluſive in theſe theories.

As to the ſpecies of *metals* there are four imperfect, becauſe their principles are not bound ſo faſt together, but that the force of a common fire deſtroys them; theſe are *iron*, *copper*, *lead* and *tin*: and the two which being proof againſt common fire, is *gold* and *ſilver*, are called *perfect metals*.

In the *four firſt*, it is eaſy to ſee the principle of inflammability; they become all fuſible by the addition of *ſalt-petre*, either in a greater or leſs degree.—Iron is that, wherein this is the moſt viſible; next, *tin*, then *copper* and *lead*.

In *gold* and *ſilver*, the ſulphurous principle is not ſo obvious; no heat, but that of the ſun collected into a focus, is able to decompound them: but no doubt they have the ſame principles with the other *metals*, though not ſo eaſily ſeen.—In gold, as well as in other *metals*, is an earth capable of vitrification, as appears by the glaſs remaining after the calcination of gold in a burning glaſs; and there is reaſon to believe, that the greateſt part of what is exhaled in ſmoak, during the operation, is the ſulphurous principle mixed with ſalts.

As to *ſilver*, there is ſomething in it extremely various: when purified with *antimony*, it vitrifies with a burning-glaſs; but if purified with *lead*, it leaves nothing behind, but grey aſhes.—The baſis of this *metal* is doubtleſs an earth, capable of vitrification; and what exhales in ſmoke, is apparently a mixture of ſulphur, ſalt, and a little earth volatilized by the fire.

From all which, and many more obſervations of the ſame kind, M. *Geoffroy* draws the following concluſions, that the ſubſtances whereof *metals* are compoſed, do not differ eſſentially from thoſe which compoſe vegetables. That the imperfect *metals* are compoſed of a ſulphur, vitriolick ſalt, and vitrifiable earth. That this ſulphureous principle is more or leſs ſtrongly joined with the other principles; very ſtrongly in gold and in ſilver, leſs in antimony, and very little in mineral ſulphur. That the principle of inflammability may be ſeparated from metallick ſubſtances, either by cunilary fire, or by the ſun. That the *metal*, thus deſpoiled of its principle, is converted into aſhes, and that theſe aſhes, purſued further with a violent fire, vitrify; and that ſuch aſhes or glaſſes, by the application of ſome inflammable matter, re-aſſume the metallick form they had loſt. That it is by this means linſeed-oil turns argilla into iron. That if we knew all the other metallick earths, they might likewiſe be immediately converted into *metals*, by the projection of ſome inflammable matter. That it is the ſaline and earthy parts, found in oil of vitriol, that furniſh the earthy vitrifiable part, which makes the baſis or ground of iron, and that it receives the *metallick* form from the ſulphurous principle of the oil. That the iron found in the aſhes of plants, was produced there in the ſame manner: and, that it is a compoſition of the vitrifiable earth of the plants, the acid of theſe plants, and their oily or inflammable principle.

GOLD is a yellow *metal*; the heavieſt, pureſt, moſt ductile, and ſhining, and on thoſe accounts the moſt valuable of all *metals*.

The weight of gold is to that of water, as 19636 to 1000.——A cubick inch of pure gold weighs twelve ounces, two drachms, and fifty-two grains; and the cubick inch of ſilver, ſix ounces, five drachms, twenty-eight grains.—— The pound weight, or twelve ounces Troy of gold, is divided into twenty-four carats.

The value of *gold* is to that of ſilver as 14 to 1; indeed, this proportion varies as gold is more or leſs plentiful: for *Suetonius* relates, that *Cæſar* brought ſuch a quantity of gold from *Italy*, that the pound of gold was only worth ſeven pounds and a half of ſilver.—Standard gold is worth 44 *l.* 10 *s.* Sterling the pound weight: ſtandard ſilver is worth 3 *l.* the pound, or 5 *s.* the ounce.

The firſt characteriſtick, or property of *gold*, is that it is the heavieſt of all bodies, proceeding from the union or coheſion of its parts, which is cloſer and more intimate than in any other *metal*.

The ſecond character is, that of all known bodies it is the moſt ductile and malleable.

The third character of *gold* is its fixedneſs in the fire, in which it exceeds all other bodies. The Prince of *Mirandola*, Mr. *Boyle*, and other Chymiſts, furniſh divers experiments to illuſtrate this wonderful fixity. After laying a quantity of *gold* two months in the intenſeſt heat imaginable, it is taken out without any ſenſible diminution of weight. It muſt be added however, that in the foci of the large burning glaſſes of *Tſchirnhauſen* and *Vilette*, even gold itſelf volatilizes and evaporates. After this manner we are told from the Royal Academy at *Paris*, a quantity of pure gold was vitrified (which contradicts the ſentiment of Meſſ. *Boerhaave* and *Homberg*, that no ſalts enter the compoſition of gold) and that the glaſs being fuſed with a quantity of greaſe was reſtored into gold; which is a confirmation that there muſt be ſome ſulphurous particles in the formation of gold, wherein the moſt acute points of the ſaline ones are ſheathed.

Its fourth character is, not to be diſſoluble by any menſtruum in nature, except aqua regia and mercury, the baſis of aqua regia being ſea-ſalt, which

is the only ſalt we know of that has any effect on gold.

The ſeventh character is, that it readily and ſpontaneouſly, as by ſome magnetick virtue, attracts and abſorbs mercury.

The eighth character is, that it withſtands the violence both of lead and antimony, *i. e.* being fuſed in the coppel along with either of thoſe matters, it does not diſſipate and fly off with them in fume, but remains fixed and unchanged.

The ninth character is, that of all bodies it is the ſimpleſt, (the primary elements being here excepted) by ſimple we here mean that the minuteſt part has all the phyſical property of the whole maſs. Thus if a grain of *gold* be diſſolved in aqua regia, and a ſingle drop of the diſſolution be taken, a quantity of *gold* may be ſeparated therefrom, which ſhall only be the millionth part of the grain, and yet have all the characters of *gold*. Or if you fuſe a grain of *gold* with a large maſs of ſilver, and mix the two together, ſo that the *gold* become equally diffuſed through the whole maſs; you will have in every particle of the maſs a particle of perfect *gold*; accordingly diſſolve any part of the mixture in aqua fortis, and a quantity of *gold* will precipitate to the bottom; bearing the ſame proportion to the grain that the part diſſolved did to the whole maſs, on which principle depends the art of aſſaying.

All the known parts of the earth afford this precious *metal*; though with a deal of difference in point of purity, and abundance: *Europe*, ſo fertile in other reſpects, comes ſhort of all other quarters in *gold*. *America* furniſhes the moſt; and particularly the mines of *Peru* and *Chili*. That of *Aſia* is eſteemed the fineſt, particularly that of *Meranicabo* in the *Eaſt Indies*: though the *Spaniards* aſſure us, that they get *gold* out of ſome of their *Peruvian* mines, twenty-three carats fine, before it be purified. The *gold* of *Axima* on the coaſt of *Africa*, is found from twenty-two to twenty-three carats.

Gold is chiefly found in mines; though there is ſome, alſo found in the ſand, and mud of rivers, and torrents, particularly in *Guinea*: this laſt is in form of a fine duſt, and for that reaſon called *gold duſt*.

The *gold* of mines is of two kinds: the one in ſmall pieces, or grains of various forms and weights.

The other kind of *gold* is dug up in ſtony glebes, which is what they call the *mineral* or *ore of gold*: theſe glebes are of various colours, and uſually one hundred and fifty, or one hundred and ſixty fathoms deep. Along with the *gold* they uſually contain ſome other mineral matter, as antimony, vitriol, ſulphur, copper, or ſilver, particularly the laſt; without ſome ſhare of which it is ſcarce ever found.

To ſeparate the *gold*, they firſt break the *metalline* matter with iron mallets pretty ſmall, then carry it to the mills, where it is grounded into a very fine powder; and laſtly, paſs it through ſeveral braſs-wire ſieves one after another, the laſt as fine as any of our ſilk ſieves.

The powder thus prepared is laid in wooded troughs, with a proper quantity of mercury and water, and there left to knead and ſaturate in the ſun and air, for twice twenty-four hours. After this the water with the recrementitious earth is drove out of the tube, by means of other hot waters poured thereon. This done, there remains nothing but a maſs of mercury with all the *gold* that was in the ore. The mercury they ſeparate from it by diſtillation, in large alembicks: the gold in this ſtate is called *virgin gold*, as well as that found in the ſand of rivers, or that in grains in the mines, in regard none of them have paſſed the fire. After this they uſually fuſe it in crucibles, and caſt it into plates or ingots.

SILVER is a white, rich ſort of metal; being the fineſt, moſt ductile, and moſt precious of all *metals* except *gold*. It receives in its compoſition a greater number of ſulphurous particles than gold, and leſs defecated, whence it is ſubject to more mutations; and is diſſolved with a greater facility.

There are *ſilver* mines in all the four quarters of the world. *Europe* has its ſhare, nor is *Britain* quite deſtitute thereof.

The mines of *Peru*, and ſome other parts of *America*, are much the richeſt and moſt abundant; they appear almoſt inexhauſtible, particularly thoſe of *Potoſi*.

The ores or mineral ſtones they dig, are ſome white or aſh-colour, ſpotted with red or blue, and called *plata blancha*; others are black, and called *promo ranco*: theſe laſt are the richeſt, and the eaſieſt wrought, no mercury have been here needed, nor any thing but to put them in the fire, where the lead evaporating, leaves the ſilver pure. The *roſſiclee* is another black mineral diſtinguiſhed by whetting and rubbing it againſt iron, which turns it red. It is very rich, and the *metal* it yields of the beſt ſort. The *joroche* burns like talc, and looks as if ſilvered, though it does not yield much. The *paco* is a yellow red, very ſoft, and found almoſt broke in pieces; it is not rich. The *cobriſſo* is green and half friable. Though the ſilver of this be viſible, yet it is drawn from it with great difficulty, by reaſon of the copper wherewith it is intermixed. Laſtly, the *araunea*, which is only found in *Potoſi*, and that only in the mine of *Cotamito*, conſiſt of threads of pure ſilver, interwove like a *ſilver* galoon, that has been burnt to get out the ſilk.

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The moſt uſual way of ſeparating the *ſilver* from the ore, is by what they call *pinea's*. Sometimes, however, they uſe nothing but fire frequently repeated, or aqua fortis.

The manner of doing it by *pinea's*, is to break firſt the ore, or mineral *ſilver* dug out of the veins of the mine; then grind it in mills for the purpoſe, driven by water, with iron peſtles of two hundred pound weight. The mineral thus pulverized, is next ſifted, then worked up with water into a paſte, which when half dry is cut into pieces, called *cuerpo's*, a foot long; weighing each about two thouſand five hundred pounds.

Each *cuerpo* is again kneaded up with ſea ſalt, which diſſolving incorporates with it. They then add mercury, from ten to twenty pounds for each *cuerpo*, kneading the paſte afreſh until the mercury be incorporated therewith.

This amalgamation is continued for eight or nine days: ſome add lime, lead, or tin ore, *&c.* to forward it; and in ſome mines they are obliged to uſe fire. To try whether or no the mixture or amalgamation be ſufficient, they waſh a piece in water, and if the mercury be white, it has had its effect; if black, it muſt be further worked.

When the water runs quite clear out of the baſons, they find the mercury and ſilver at bottom incorporated. This matter they call *pella*, and of this they form the *pinea's* by expreſſing as much of mercury as they can; firſt by putting it in woollen bags, and preſſing and beating it ſtrongly, then by ſtamping it in a kind of wooden mould of an octagonal form, at the bottom whereof is a braſs plate pierced full of little holes.

The matter being taken out of the mould is laid on a trivet, under which is a large veſſel full of water, and the whole being covered with an earthen head, a fire is made around it.

The mercury ſtill remaining in the maſs is thus reduced into fumes, and at length condenſing is precipitated into the water, leaving behind it a maſs of ſilver grains of different figures, which only joining or touching at the extremes, render the matter very porous.

Though the mines of *Potoſi* and *Lipes* ſtill keep up their reputation, yet are there ſeveral diſcovered within theſe few years, that exceed them much in richneſs: ſuch are the mines of *Aruro*, eight leagues from *Arica*, and thoſe of *Alachæ* near *Cuſco*, open'd in 1712. It is remarkable that moſt of the mines in *America*, are found in cold and barren places.

The method of ſeparating *ſilver* from the ore, in *Europe*, is the ſame as that of gold; that is, by means of quickſilver; with this difference, that for *ſilver*, to every fifty hundred weight of ore, is added one hundred weight of rock ſalt, or ſome other natural ſalt.

To ſeparate the *ſilver* from the mercury, wherewith it is amalgamated, they have a furnace open a-top; and the aperture covered with a kind of a capital made of earth, of a cylindrical form; that may be clapped on or taken off at pleaſure. The maſs of *ſilver*, and mercury being laid in the furnace, the capital applied, and the fire lighted underneath; the quickſilver raiſed by the action of the fire, in form of vapour, is caught in the capital, and taken thence to be uſed in the ſecond operation.

The ſtandard of fine *ſilver* is 12 penny-weights, each conſiſting of 24 grains: when it is below this, it muſt be raiſed to it by refining.

COPPER is a hard, dry, heavy, ductile metal, found in mines in ſeveral parts of *Europe*.

Copper is of all *metals* the moſt ductile, and malleable, after gold and ſilver; and abounds much in vitriol, and an ill-digeſted ſulphur.

Copper is found in glebes or ſtones of various forms and colours; which are firſt beaten ſmall and waſhed, to ſeparate them from the earthy, *&c.* parts wherewith they are melted, and the melted matter run into a kind of moulds, to form large blocks, by ſome called *ſulmons*, and by others *cakes of copper*: this is the ordinary *copper*.

To render it more pure and beautiful, they melt it again once or twice; ſome of its coarſe earthy parts being left at each fuſion, and a quantity of tin and antimony added in each: in this ſtate it is called *roſe copper*, in Latin *æs peloſum*.

Copper is alſo, ſometimes, found native and pure in the mines, either in form of threads, or in flakes, plates, grains, or other makes and lumps: this is called *virgin copper*.

Of a mixture of *copper* and *lapis calaminaris*, is formed braſs.

IRON is a hard, fuſible, and malleable metal, of great uſe in the affairs of life: it conſiſts of an earth, ſalt, and ſulphur, but all impure, ill mixed, and digeſted, which renders it extremely liable to ruſt.

Iron is the hardeſt, drieſt, and the moſt difficult to melt of all *metals*. It may be ſoftened by heating it often in the fire, hammering it, and letting it cool of itſelf; and it is hardened, by extinguiſhing it in water.

There is a great number of *iron* works in moſt parts of *England*, thoſe in the foreſt of *Dean* in *Glouceſterſhire* are in moſt repute. The ore is there found in great abundance, differing much in colour, weight, and goodneſs. The beſt called *ruſh ore*, is of a bluiſh

bluiſh colour, very ponderous, and full of little ſhining ſpecks, like grains of ſilver; this affords the greateſt quantity of *iron*, but being melted alone produces metal very ſhort and brittle, and therefore not ſo fit for common uſe: for the remedying whereof the workmen make uſe of another ſort of material termed *cinder*, which is nothing but the refuſe of the ore, after the metal has been extracted; and which being mingled with the other, and in a due quantity, gives it that excellent temper of toughneſs, which cauſes this *iron* to be preferred before any brought from foreign parts.

After they have provided the ore, they firſt work it to calcine it, which is done in kilns, much after the faſhion of our ordinary lime-kilns: this they fill up to the top with coal and ore, one lay upon another; and ſo putting fire at the bottom they let it burn till the coal be waſted, and then renew the kilns with freſh ore and coal, in the ſame manner, as before. This is done without fuſion of the metal, and ſerves to conſume the more droſſy part of the ore, and to make it malleable, ſupplying the beating and waſhing, which are uſed in other metals.

From hence they carry it to their furnaces, which are built of brick or ſtone, about 24 feet ſquare on the outſide, and near 30 feet in height within, not above 8 or 10 feet over where wideſt, which is about the middle; the top and bottom having a narrow compaſs, much like the ſhape of an egg. Behind the furnace are fixed two large pair of bellows, the noſes of which meet at a little hole near the bottom; theſe are compreſſed together by certain buttons placed on the axis of a very large wheel, which is turned about by water, in the manner of an over-ſhot mill. As ſoon as theſe buttons are ſlid off, the bellows are raiſed again by the counterpoiſe of weights, whereby they are made to play alternately, one giving its blaſt while the other is raiſing.

At firſt they fill the furnace with ore and cinder, intermixed with fuel, which in thoſe works are always wood or charcoal, laying them hollow at the bottom, that they may more eaſily take fire; but after they are once kindled, the materials run together in a hard cake or lump, which is ſuſtained by the faſhion of the furnace; and through this the metal, as it melts, trickles down into the receivers ſet at the bottom, where there is a paſſage open, by which the men take away the ſcum and droſs, and let out the metal, as they ſee occaſion. Before the mouth of the furnace, there lies a great bed of ſand, wherein they make furrows of the ſhape, into which they would have their *iron* caſt. As ſoon as the receivers are full, they let in the metal, which is made ſo very fluid by the violence of the fire, that it not only runs to a conſiderable diſtance, but ſtands afterwards boiling for a good while.

When the furnaces are once at work, they keep them conſtantly employ'd for many months together, never ſuffering the fire to ſlacken night or day, but ſtill ſupplying the waſting of the fuel, and other materials, with freſh poured in at the top: charcoal is uſed altogether in this work, ſea-coal will ſcarcely do.

From theſe furnaces the workmen bring their *ſows* and *pigs* of *iron*, as they call them, to their forges, where it is wrought into bars.

TIN is a whitiſh metal, ſofter than *ſilver*, yet much harder than *lead*.

The conſtituent parts of *tin*, and thoſe of *ſilver*, are no otherwiſe different from one another, but in their preparation, which is leſs perfect in *tin* than in *ſilver*, and in their coheſion, which is leſs intimate in *tin* than in *ſilver*.

Mr. *Boyle*, and others, give us ſeveral inſtances of ſilver being actually produced in conſiderable quantities from *tin* ore.

There are mines of *tin*, as well as other metals; the beſt are in *England*, in the counties of *Cornwall* and *Devonſhire*; from whence the greateſt part of the *tin* conſumed in *Europe* is procured.

The mineral ſtone or ore, being dug and drawn out of the mine, is there broke into pieces with large iron mallets; then brought to a ſtamping mill, where it is ſtill pounded ſmaller with ſtampers, much like thoſe of paper-mills; and the water paſſing through it, waſhes away the earthy parts, leaving the metallick ones behind: the lotion is repeated twice to make the better ſeparation.

This done, they dry it in a furnace on iron plates, and grind it very fine in a craſing mill; then waſh it again and dry it: in this ſtate the metallick matter is called *black tin*.

To convert it into tin, *i. e.* into *white tin*, they carry it to a furnace or blowing-houſe, where, by means of a charcoal fire, kept up by huge bellows worked with water, it is melted; after it has paſſed all theſe preparations and is become cold, they forge it, which is the laſt thing done to it in in the works.

The droſs or ſcoria ſcummed off the *tin* in fuſion, being melted down with freſh ore runs into metal, and even the *caſualty*, i. e. the matter waſhed and ſeparated from the metal in the mill, being thrown up in heaps, after reſting ſix or ſeven years they fetch it over again, and it yields as good tin as any of that of *Germany*.

The workmen diſtinguiſh ſeveral kinds of *tin*, as *moor tin*, which is the beſt ſort, a foot whereof weighs 80 pounds; and *mine tin*, which is the next,

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a foot whereof weighing about 50 or 52 pounds. The *tin* got from the ſoft gravelly earth, they call *pryan tin*, to diſtinguiſh it from that got from the ſtones, which is better by almoſt half. Two pounds of *black tin* when melted yield about one of *white*.

To find whether *tin* be ſoft and ductile, or harſh and ductile, there are two kinds of eſſays: the *firſt* is, by putting the *tin* in a mould of caſt braſs, and there melting it; if the metal be harſh, it will be taken out heavier than before, otherwiſe it will be lighter. The *ſecond* is, by caſting the melted *tin* into a little mould made of the Thunder-ſtone. This mould has a little canal of moderate length, which conducts the matter into a cavity capable of containing half a billiard ball; if the *tin* be harſh it appears whitiſh towards the entry of the mould, otherwiſe it is tinged ſuperficially with a very faint bluiſh brown.

LEAD is a coarſe, heavy, impure metal, of all others the ſafeſt and moſt fuſible when purified.

They who have made an analyſis of *lead*, find it to contain a little mercury, ſome ſulphur, and a great deal of bituminous earth.

Lead is found in various countries, but abounds particularly in *England*; it is found too in ſeveral kinds of ſoils and ſtones, ſome whereof beſides, contain gold, ſome ſilver, others tin, *&c.*

It is melted in a furnace, with a ſtrong coal-fire; as it melts it runs through a canal on one ſide, leaving the earth, ſtones and ſcoria with the aſhes of the coals. It is purified by ſkimming it ere cold, and throwing ſuet and other fat bodies into it.

Lead is found of a lighter or deeper colour, according as it is more or leſs purified, though ſome make a difference in the colour of the ore, always eſteeming that moſt which is the whiteſt.

Some very able Naturaliſts obſerve, that the weight of *lead* increaſes either in the open air, or under ground.

Lead is a metal of much uſe, it eaſily melts, and mixes with gold, ſilver, and copper, and communicates its humidity to them; but not being able to endure the fire, which they undergo, it retires and carries with it all that was heterogeneous in them, ſo as neither gold nor ſilver are refined without *lead*. To which may be added, that the coarſer kind of precious ſtones boiled in *lead* are thereby rendered much more brilliant.

When the lead ore is dug out they beat it ſmall; then waſh it clean in a running ſtream, and ſift it in iron rudders. Their hearth or furnace is made of clay or fire-ſtone; this they ſet in the ground, and on it build their fire, when they light their charcoal, continuing it with young oaken gads blown with bellows, by men treading on them. After the fire is lighted and the fire-place hot, they throw their *lead* ore on the wood, which melts down into the furnace, and then with an iron ladle they take it out, and upon ſand caſt it into what form they pleaſe.

The ore runs ſometimes in a vein, ſometimes is diſperſed in banks; it lies many times between rocks, ſome of it is harder, others milder; ſometimes they have branched ore in the ſpar, about the ore is ſpar and caulk, and another ſubſtance which they call crootes.

MERCURY, or QUICKSILVER, is an imperfect *metal*, neither ductile nor malleable, but only a fluid matter perfectly reſembling ſilver in fuſion.

The common name among the antients was *hydrargirum*, q. d. water of ſilver.

Boerhaave obſerves, that it is very improperly called a *metal*, inaſmuch as it has not all the characters of ſuch a body, nor ſcarce any thing in common with the other *metals* except weight and ſimilarity of parts.

The characters of *mercury* are, firſt, that of all bodies it is the heavieſt after gold; and ſtill the purer it is the heavier; nay ſome of the Philoſophers even hold, that *mercury* well purged of all its ſulphur, would be heavier than gold itſelf. The ordinary proportion is, that of fourteen to nineteen.

The ſecond character of *mercury*, is to be of all bodies the moſt fluid, that is, its parts ſeparate, and recede from each other by the ſmalleſt force.

The third property of *mercury* is, that in whatever manner it be divided, it ſtill retains its nature, and is the ſame ſpecifick fluid.

The fourth character is to be extremely volatile, being convertible into fume, even by a ſand heat.

The fifth property is, that it eaſily and intimately adheres to gold, leſs eaſily to the other metals, with difficulty to copper, and not at all to iron. On this account it is that ſuch as have occaſion to handle *quickſilver*, always make choice of iron inſtruments for that purpoſe. We have known women in a ſalivation, to have their ear-rings grow white and ſoft with the effluvia of the *mercury*. And hence the gilders, to lay gold on any other body, diſſolve it in hot *mercury*, which done, they apply the ſolution on the body to be gilt, ſuppoſe ſilver; then ſetting it over the coals the *mercury* flies away, and leaves the gold adhering like a cruſt to the ſilver. Laſtly, rubbing the cruſt with *lapis hæmatites*, the ſilver is gilt.

The ſixth character is, that of all fluids it is the coldeſt, and the hotteſt, ſuppoſing the circumſtances the ſame.

The ſeventh property is, that it is diſſoluble by almoſt all acids, and unites itſelf with them, at leaſt

with all foſſil acids. Thus it is diſſolved in oil of vitriol, ſpirit of ſulphur *per campanam*, ſpirit of nitre and aqua regia.

Only vinegar does not diſſolve it, and hence we are furniſhed with a method of detecting the frauds of druggiſts, *&c.* who make a practice of ſophiſticating quickſilver with lead. Do but take a mortar, and pound the *mercury*, with vinegar therein; if the vinegar grow ſweetiſh, it is a proof there is a mixture of lead: if copper have been mixed with it, the *mercury* will turn bluiſh or greeniſh; if there be no adulteration, the *mercury* and vinegar will both remain as before.

The eighth property is, that it is the moſt ſimple of all bodies next after gold; accordingly we find it the ſame in all its parts, ſo far as our obſervation goes. If a ſingle grain of *mercury* be diſſolved in ſpirit of nitre, a proportionable part of the grain will be diſtributed into every minute particle of the menſtruum; and by diluting the whole with an ounce of aqua ſtygia, the whole grain of *mercury* will be revived.

The ninth property of *mercury* is, not to be in any meaſure acrid, for it ſhews no acrimony to the taſte, nor does it corrode any body; and if a carcaſe were to be buried in quickſilver, it might doubtleſs remain there without being any way hurt.

Mercury is found in mines, the chief of which are thoſe of *Hungary*, *Spain*, *Friuli*, and *Peru*; the greateſt part of our *quickſilver* is brought us from *Friuli*, where there are abundance of mines belonging to the Queen of *Hungary*, though mortgaged to the *Dutch*. It is found under three ſeveral forms: 1. In ruddy glebes, or clods, called *cinnabar*. 2. In hard ſtony glebes, or a mineral ſubſtance of a ſaffron, and ſometimes a blackiſh colour. 3. It is alſo found pure; for upon opening holes in the beds of ſtones, *&c.* there ſometimes guſhes a vein or ſtream of pure *mercury*, call'd *virgin mercury*. This laſt ſort is moſt valued.

To procure or ſeparate *mercury* from the ore or earth, they firſt grind the glebe into powder; this done they pour a great quantity of water upon it, ſtirring and working the whole briſkly about till the water becomes exceeding thick and turbid: this water having ſtood till it be ſettled, they pour it off, and ſupply its place with freſh, which they ſtir and work as before: this they repeat, and continue to do, till the water at length comes away perfectly clear, then all remaining at the bottom of the veſſel is *mercury*, and other metalline matter.

To this *mercury*, &c. they add the ſcoria of iron, putting them together in large earthen retorts, and ſo diſtilling it; by which means all the heterogeneous, metallick and ſtony part is ſeparated therefrom, and the *mercury* left pure.

As to the earthy matter wherewith the *mercury* is mixed, that of *Spain* is red, and ſpeckled with black and white, and ſo hard that it is not to be broken up with gun-powder. In *Hungary* it is frequently a hard ſtone, but ordinarily a reddiſh earth. In *Friuli* there is a ſoft earth where the *virgin quickſilver* is found; and a hard ſtone which yields the common *mercury*.

The mine of *Idica*, one of thoſe belonging to *Friuli*, is ſo rich, that it yields always half *quickſilver*, ſometimes two thirds.

The mine of *Juan Cabelaca* in *Peru*, is ſtill more conſiderable; the earth is of a whitiſh red, like bricks half burnt; it is firſt broke, then expoſed to the fire, by ſpreading it on a layer of common earth, wherewith the grate of an earthen ſurface is covered, under which is lighted a little fire of an herb, called by the *Spaniards icho*; which is of that neceſſity in thoſe works, that the cutting of it is prohibited for the ſpace of 20 leagues round. In proportion as the mineral heats, the *mercury* riſes volatilized into ſmoak; which ſmoak finding no vent through the capital of the furnace, which is exactly luted, eſcapes through a hole made for the purpoſe, communicating with ſeveral earthen cucurbites fitted within one another. The water at the bottom of each cucurbite condenſing it to ſmoak, the *quickſilver* precipitates, and is taken up when the operation is over. In this proceſs there are three things remarkable; the firſt, that the further the cucurbites are from the furnace, the more they are filled with quickſilver. The ſecond, that at laſt they all grow ſo hot, that they would break, were they not ſprinkled from time to time with water. Thirdly, that the workmen employ'd never hold it long, but become paralytick, and die hectick. The precaution they uſe is, to hold a piece of gold in their mouth, to imbibe the effluvia, and interrupt their paſſage into the body. Dr. *Pope* tells us of one he ſaw in the mines of *Friuli*, who in half a year's time was ſo impregnated with the metal, that putting a piece of braſs in his mouth, or even rubbing it in his fingers, it would turn as white as ſilver.

The method of purifying mercury is, by waſhing it ſeveral times in vinegar, wherein common ſalt hath been diſſolved; or by paſſing and repaſſing it frequently over a ſhammy ſkin. *Am. Parœus* tells us, that the beſt way is to make a dog ſwallow a pound at a time, and afterwards to ſeparate it from the excrement, and waſh it in vinegar.

I'll conclude this treatiſe, by obſerving that the common radical character of *metals* is, that of all known bodies they are the heavieſt. By Dr. *Halley*'s experiments, the weight of gold to that of glaſs is determined to be as 9 to 1; and the weight of tin

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the lighteſt of all metals to that of gold, as 7 to 19; which conſiderably ſurpaſſes the weight of all ſtones, marbles, gums, and other the moſt ſolid bodies, as appears from the tubes of ſpecifick gravity: nor is there any body in nature but a *metal*, that is one third of the weight of the gold.

The Royal Society furniſhes us with various experiments of that kind. The weights of the ſeveral *metals* and other ſolids, they have examined hydroſtatically, by weighing them in air and in water; and the weights of the fluids by weighing an equal portion of each. By ſuch experiments they find, that taking the ſame weights of water and gold, the bulk or magnitude of the former is to the latter as 19636 to 1000; conſequently that the weight of gold is to water nearly as 19 to 1.

The ſpecifick weight of the ſeveral *metals* by this means determined ſtands thus:

Gold - -	19636	Iron - -	7852
Quickſilver	14019	Tin - - -	7321
Lead - -	11345	Granate -	3978
Silver - -	10535	Water - -	1000
Copper - -	8843	Air - -	1½

The tube inch of

		Ounces.	*Drams.*	*Grains.*
Gold	whighs	12	2	52
Quickſilver	whighs	8	6	8
Lead	whighs	7	3	30
Silver	whighs	6	5	28
Copper	whighs	5	6	36
Iron	whighs	5	1	24
Tin	whighs	4	6	17

METALLURGY See MINERALS.

METAPHYSICKS.

METAPHYSICKS is a ſcience that treats of *being*, as ſuch in the abſtract; that is, it conſiders beings, only as beings.

All other ſciences have a neceſſary dependence on this; for, it ſupplies them with a foundation and a method to proceed upon; without which, our knowledge of any ſubject muſt be very confuſed and imperfect.

This was probably the reaſon that made *Ariſtotle* ſtyle this ſcience *the true beginning of philoſophy*, and the moſt noble of all the ſciences. As it is wholly converſant in the acts of the underſtanding, it raiſes itſelf above the verge of ſenſe and matter, by its abſtracted views.

The quantity of bodies it refers to the conſideration of *geometry*, and their ſenſible qualities to *natural philoſophy*, applying itſelf only to beings ſeparated from their individual ſingularity, ſuch as ſubſtances, accidents, relations, and whatever elſe may be conceived abſtractly from matter; but particularly *beings purely ſpiritual*, ſuch as God, *angels*, and the ſoul of man: hence *Ariſtotle* terms it *natural theology*.

The end of this ſcience is the ſearch of pure and abſtracted truth. It caſts a light upon all the objects of thought and meditation, by ranging every being with all the abſolute and relative perfections and properties, modes and attendants of it, in proper ranks or claſſes; and thereby it diſcovers the various relations of things to each other, and what are their general or ſpecial differences from each other; wherein a great part of human knowledge conſiſts: and, by this means, it greatly conduces to inſtruct us in method, or the diſpoſition of putting every thing into its proper rank and claſs of being, attributes or actions; and hence its proper affinity with *Logic*. See Method in Logic.

This will appear more ſatisfactorily, by laying before you the following *analyſis* of the *metaphyſical ſcience*.

The object of this ſcience, or that about which it is converſant, is therefore *being* in general. For, the underſtanding not being confined to one thing, as the ſenſes are to the proper objects, has a diffuſive power to comprehend whatſoever is intelligible. To avoid confuſion, which would inevitably flow from the great variety of things which fall within the compaſs of the underſtanding, it is found neceſſary to reduce the ſpecies of beings to one genus, in order to make them the object of any *art* or *ſcience*; ſo all the conceptions in *natural philoſophy* are reduc'd to that one of a natural body; all the obſervations concerning proportion, figures, and quantity to *mathematick*; and all the ideas concerning the various modes of being, ſubſiſting, and inhering, are reduc'd to one object, which is called *being*.

Being is ſeveral ways divided. 1. *Being* taken in its utmoſt latitude is either compound or ſimple, which involves many ideas, or ſimple, which only takes in one.

2. *Being* is either *poſitive* or *negative*. *Poſitive* is that, which has a real exiſtence in the courſe of nature. *Negative* deſtroys this exiſtence. If it deſtroys it abſolutely then it is a perfect negative *being*;

being; but if it only prevents its being in a ſubject, which was capable to receive it, then it is ſtil'd a privative being. For privation may be properly defin'd, to be the want or abſence of ſome natural perfection, from a ſubject capable to receive it, in which ſubject it either was before, or at leaſt ought to have been: beſides, as this privation is either greater or leſs, ſo it is either called total or partial. Total is the worſt, for it deprives the ſubject of its natural perfection, both as to the exerciſe of any preſent action, and the power of regaining it for the future; as when the eye is perfectly put out. Partial is only in ſome particular reſpect, and relates principally to its preſent actions, or ſome degree of them; as when one ſhuts his eyes, or is purblind.

3. *Being* is either *rational* or *real*. *Rational being*, which is the mere product of reaſon, has no exiſtence but in the mind in idea, and when none thinks upon it, it ceaſes to be. A *real being*, which is not produc'd by the ſtrength of imagination or fancy, has a real exiſtence in the courſe of nature, antecedent to any thought or conception of the mind.

4. *Being* is either *actual* or *potential*. *Actual* is that, which actually exiſts in the order of nature, whether it depend upon any cauſe in order to produce it, as an infant; or whether it be antecedent to all cauſe, as God. *Potential being* is that, which can be produced by the power of ſome agent.

Theſe are the principal nominal diſtinctions of *being*, and from theſe we may collect that that *being* which is the object of *metaphyſick*, is a *ſimple*, *poſitive*, *real*, and *actual being*.

Metaphyſick is divided into two parts, general and particular.

The general part of *metaphyſick* gives an account of *being* in its moſt abſtracted nature; under which notion it may be thus defin'd; *being* is that, which in itſelf has a real and poſitive eſſence.

Being may be conſidered either with reſpect to thoſe words, which are ſynonymous or equivalent to it; or in reference to its affections or modes.

Words ſynonymous to *being*, are terms, which ſimply have the ſame ſignification, or elſe, at the ſame time, do imply a reſpect to ſome other thing. Upon this ground they are divided into two claſſes; ſome in every reſpect implying the ſame with *being*, others either from the *philoſophical* or *grammatical* uſe of the words, imply a relation to ſome other *being*.

In the firſt claſs, are ranked *eſſence*, *thing*, *ſomething*.

Eſſence is the ſame with *being*, tho' ſome would make a diſtinction to lie betwixt them in this, that *being* has the ſame reſpect to *eſſence*, that the concrete has to its abſtract. But *eſſence* in *metaphyſick* is taken in its moſt abſtracted nature, and ſo it muſt of neceſſity be the ſame with *being*.

Thing is the ſame with *being*; for there is nothing in the notion of *being*, but what *thing* implies in its idea, and on the contrary.

Something, as well as *thing* and *eſſence*, is equivalent to *being*. And this may be further proved from theſe following axioms. For, *if it be impoſſible for the ſame thing to have eſſence, and not to have eſſence at the ſame time; to be a thing and not to be a thing; to be ſomething and not to be ſomething*, are maxims equivalent to this firſt principle of knowledge, *that it is impoſſible for a thing to be, and not to be at the ſame time*; then *eſſence*, *thing*, and *ſomething* are words ſynonymous to *being*.

Synonymous words of the ſecond claſs are, *exiſtence*, *quiddity*, *nature*, *form*. Theſe are the ſame with *being*, yet imply ſome reſpect in the philoſophical way of uſing them, which reſpect is form'd by the operation of the mind upon hearing theſe words.

Exiſtence, beſides the ſignification of *being*, implies a reference to its cauſe, whether it poſitively had its original from ſome cauſe, as an houſe; or negatively was antecedent to all cauſe, as God.

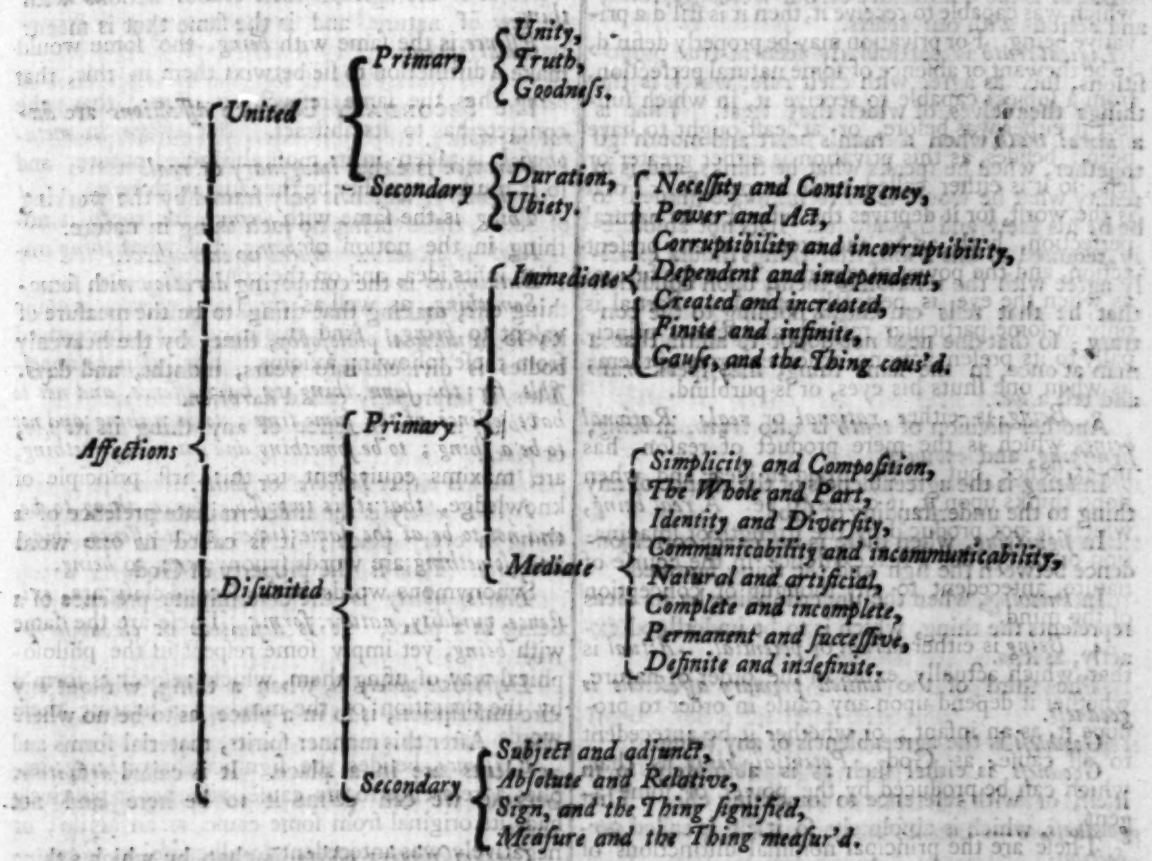
Quiddity is the ſame with *being*, but infers a relation to our underſtanding; for the very aſking what a thing is, implies that it is the object of knowledge; upon which account that, which really exiſts in the courſe of nature, is accidentally made the object of knowledge.

Nature is the ſame with *being*, but includes a reſpect to its operations and properties.

Form is of the ſame ſignification; for every *being* as by its *eſſence*, ſo by its *form*, is what it is. Yet this term involves this reſpect, that it is more generally by philoſophers apply'd to particular and determinate beings.

The *modes* or *affections* of *being*, are three general ideas or conceptions of *being*, which naturally flow from it, and are reciprocated with it, yet repreſent it in different ſtates and conditions.

Unity,



The *united affections* of *being* are ſuch as ſingly and ſolitarily are predicated of *being*, and without any conjunction are convertible with it; as every *being* is good, and all good is a *being*.

The *diſunited affections* of *being* are predicated of it with a disjunction, and by taking in both parts of the ſentence are convertible with it. As *being* is either neceſſary or contingent, and whatever is neceſſary or contingent is a *being*.

The PRIMARY UNITED *affections* of *being* are *unity*, *truth*, and *goodneſs*.

Unity is either *real* or *rational*. *Real* is, which without any operation of the mind is really in every particular *being*. *Rational unity* is that common nature which is diffus'd in all the particulars of any kind, yet by the operation of the underſtanding is made one.

Unity is the indiviſion of any *being*; *i. e.* the diviſion of its eſſence impiying ſuch a contradiction, that without we can divide a thing from itſelf it is impoſſible to divide it.

Union is the concourſe of many *beings*, in order to the making of one individual.

Union is either *verbal*, *real*, *eſſential*, *perſonal*, or *accidental*.

Verbal union conſiſts in the bare agreement of words.

Real in the concourſe of many diſtinct *beings*, in order to the forming of one individual.

That is an *eſſential union* when many *incomplete beings*, adapted to one another, do concur to make one eſſential individual: ſo matter and form are eſſentially united in the compoſition of a body. And this *union* is not only viſible in eſſential compoſitions, but in integral, becauſe even in ſuch a compoſition there is one eſſence; ſo the elements in all mixt bodies are united by an *eſſential union*.

Perſonal union is by which two natures are ſo united as to make one perſon. The only inſtance that can be given of this is, in the *union* of the divine and human nature in the perſon of our Saviour.

Accidental union is by which many cauſes accidentally concur to make one thing by accident.

The *ſecond of the united primary affections of being* is *truth*.

Truth is either *metaphyſical*, *logical*, or *moral*.

Metaphyſical truth is the conformity of the thing with the divine underſtanding.

Logical is the conformity of the idea with the thing itſelf.

Moral

Moral is the conformity of our words, geſtures, and actions with our hearts.

Logical truth is particularly ſeen in true propoſitions, ſuch as agree with their rule, which is the things themſelves of which they treat. That is a *moral truth* when a man's heart and mouth go together, when he ſpeaks what he thinks, and is in reality what he would ſeem to inſinuate himſelf to be by his ſhew and appearance. It is not abſolutely required to this *truth*, that things ſhould exactly agree with the relation of them, upon condition that he that tells 'em knows nothing to the contrary; ſo that one need not doubt to affirm that a man at once, in the ſame thing, may ſpeak *truth* and tell a *lye*.

Another diviſion of *truth* is into *truth*, in *being*, *ſignifying*, and *knowing*.

In *being* is the agreeableneſs of the eſſence of any thing to the underſtanding of God.

In *ſignifying*, when there is an exact correſpondence between the ſign and the thing ſignified.

In *knowing*, when the underſtanding by its ideas repreſents the thing, which is to be underſtood exactly, as it is.

The third of the *united primary affections is goodneſs*.

Goodneſs is the agreeableneſs of any thing.

Goodneſs is either ſuch as is abſolutely ſo in itſelf, or with reference to ſomething elſe. That *goodneſs*, which is abſolutely ſo itſelf is called *perfection*.

Perfection is either *eſſential* or *accidental*.

Eſſential perfection is, when a thing has no eſſential defect in its nature.

Accidential perfection, when a thing is inveſted with all thoſe accidents, which uſually accompany its *ſpecies*.

Again, *perfection* is either *abſolute* or *comparative*.

Abſolutely, every being is perfect, which wants nothing to the compleating of its eſſence.

Comparatively, one being is more perfect than another; as God is more perfect, than his creatures; a man, than a plant.

That *goodneſs*, which is *relative*, and bears a reference to ſomething elſe, is either *real* or *apparent*.

Real goodneſs is ſuch as is intrinſically ſo in its nature; as virtue.

Apparent is made ſo by the falſe reaſonings of men: thus many look upon idleneſs to be *good*.

Again, *goodneſs* is either *metaphyſical*, *phyſical*, or *moral*.

Metaphyſical is the agreeableneſs of any thing with the divine will.

Phyſical is the agreeableneſs of any particular to the whole *ſpecies*.

Moral is the agreeableneſs of our actions with the law of nature, and is the ſame that is meant by *moral virtue*.

The Secondary United *affections* are *duration*, *ubiety*.

Duration is either *imaginary* or *real*.

Imaginary, which is only fram'd by the working of fancy, there being no ſuch thing in nature.

Real is either *extrinſical* or *intrinſical*.

Extrinſical is the comparing *duration* with ſomething elſe, making that thing to be the meaſure of it; ſo in *natural philoſophy*, time, by the heavenly bodies is divided into years, months, and days. This is improperly called *duration*.

Ubiety is the preſence of any thing in its *ubi*, or *place*.

Ubiety is either *infinite* or *finite*.

Infinite ubiety is the indeterminate preſence of a thing in every place; it is called in one word *ubiquity*. This is the property of God.

Finite ubiety is the determinate preſence of a being in a place. It is *definitive* or *circumſcriptive*.

Definitive ubiety is, when a thing, without any circumſcription, is ſo in a place, as to be no where elſe. After this manner ſpirits, material forms and accidents are in a place. It is called *definitive*, becauſe we can define it to be here and not there.

Circumſcriptive ubiety is that, by which a thing is exactly circumſcrib'd in its *ubi*, and this is properly called place; this is the condition of all bodies.

The Disunited primary *immediate affections* of beings are; *neceſſity and contigency*, *power*, *and act*, *corruptibility and incorruptibility*, *dependent and independent*, *created and increated*, *finite and infinite*, *cauſe and the thing cauſed*.

Neceſſity is that, by which a being is put into ſuch a condition, that it cannot be in any other.

Neceſſity is either *abſolute* or *hypothetical*.

Abſolute neceſſity is, when it is contrary to the very nature of the things, and its principles to be otherwiſe. This is either *ſimply abſolute* or *reſpectively ſo*.

Simple abſolute neceſſity is, which upon no terms will let a thing be in another condition than what it is in. This is never met with but in an independent being, *i. e.* God.

Reſpective abſolute neceſſity is when, according to the order of the creation, and the ſettled courſe of ſecond cauſes, a thing will continue as it is.

Power is, by which a being is able to effect or do ſomething. It is either *active* or *paſſive*. *Active*

by

by which it is able to do ſomething. *Paſſive* by which it is made capable to ſuffer.

Act is that, by which a *being* is in real action: ſo walking is an *act*, not as it is in any ones power, but as it is really perform'd.

Corruptibility is a power not to be. *Corruptibility* proceeds either from *without* or from *within*. *Corruptibility* from *within* is when a thing contains the principles of its own deſtruction. From *without* when a thing may be deſtroyed by an external principle,

Incorruptibility is an inhability not to be.

Dependent is a previous want, whereby one thing depends upon another as its cauſe.

Independent is whereby one thing does not depend upon another as its cauſe.

Creation is the production of a thing out of nothing, or out of indiſpos'd or unqualified matter, by the influence of an Almighty power.

Created is that, which by *creation* has its dependance upon another, as all finite beings.

Increated, which does not depend upon another by creation; as God.

Finite, which has terms or bounds of its *eſſence*.

Infinite is either ſo *in itſelf*, or with *reſpect to us*. That, which is infinite in itſelf, is what properly belongs to *metaphyſicks*; not that, which is only ſo with reference to us, as the ſtars, and ſand; becauſe their number cannot exactly be diſcovered by any man.

Infinite is that which implies a contradiction to have terms or bounds to its *eſſence*; ſuch God is only.

A *cauſe* is an active principle influencing the thing cauſed. A *cauſe* is either *internal*, which partakes of the eſſence of the thing cauſed, *viz. matter* and *form*. Or *external*, which has an outward influence, viz. *efficient* and *final*.

Matter is an *internal cauſe*, out of which a thing is made.

Form is an *internal cauſe*, by which a material being is conſtituted what it is.

Efficient is an *external cauſe*, from which any thing by a real action derives its being or eſſence.

The *end* is an *external cauſe*, upon whoſe account the *efficient* acts.

The *thing cauſed* is that, which derives its being or eſſence from its cauſes.

So far we have conſidered the *primary*, *immediate*, *disjoin'd*, or diſunited affections of being. We come now to conſider thoſe, which flow from *being*, thro' the mediation of the *united affections*.

From *unity* flows *ſimplicity and compoſition*; the *whole and part*; the *ſame and different*; *communicability and incommunicability*.

Simplicity is an indiviſible unity. It is either *abſolute* or *limited*. *Abſolute ſimplicity* is when a thing is independently indiviſible. This is the property of God.

Limited ſimplicity, when a thing is really indiviſible; but yet that depends upon ſome external being.

Compoſition is a diviſible unity.

The *whole* is that, which is made up of parts united in due order and diſpoſition. The *whole* is either *eſſential* or *integral*.

Eſſential, which conſiſts of ſuch parts as compleat the eſſence of that being; ſo man is made up of ſoul and body.

Integral, which has the ſame nature with its parts; as every drop of water is called water.

Part is that, which conſtitutes the *whole*.

Identity is the agreement of two or more things in another.

Communicability is, when one being can partake of another.

Incommunicability, when one being cannot partake of another.

From *truth* follows *natural* and *artificial*.

Natural is that, of whoſe truth the underſtanding of God is the immediate rule.

Artificial, the immediate rule, of whoſe truth is the underſtanding of the artificer.

From *goodneſs* flows *compleat* and *incompleat*.

Compleat is that, whoſe eſſence is bounded in itſelf, and is not deſign'd to perfect any thing elſe.

Incompleat, whoſe eſſence is not bounded in itſelf, but is ordain'd of itſelf to the completion and perfection of another being.

From *duration*, proceeds *permanent* and *ſucceſſive*.

Permanent, the parts of whoſe eſſence are not in a perpetual flux.

Succeſſive, the parts of whoſe eſſence are in a continual flux.

From *ubiety* flows *definite* and *indefinite*.

Definite, which has a finite *ubiety*, or place.

Indefinite, which has an infinite *ubiety*, or place. Such a being God is, whoſe eſſence is boundleſs.

The SECUNDARY DISUNITED *affections*, are *ſubject* and *adjunct*; *abſolute* and *relative*; *ſign*, *and the thing ſignify'd*; *meaſure*, *and the thing meaſur'd*.

Subject is a being, which has another thing join'd to it, which other thing does not enter into its eſſence.

The *adjunct* is that, which is join'd to another thing, ſo as not to conſtitute part of its being.

A being is then *abſolute*, when it has no reſpect to any thing elſe.

Relative, when it has a respect to something else.

A *sign* is that, which represents any thing to the faculties of knowledge; under which faculties, are comprehended sense, as well as understanding. The thing *signify'd* is whose *idea* by its *sign* is represented to the faculties of knowledge.

Measure is that, by which the quantity of any thing is found out.

The thing *measur'd* is, whose quantity is determined by another.

Thus we have run through all the *affections* of *being*, which is the general part of *Metaphysicks*. We proceed now to the *particular part*, which is concerning the division of *being*.

Being is divided into *substance* and *accident*.

Substance is a *being* subsisting by itself. *Substance* is either *compleat* or *incompleat*.

Compleat substance, whose essence is bounded in itself, and is not ordain'd to the intrinsical perfection of any thing else. As God, an angel, a man, &c.

Compleat substance is that, which is ordained to the perfection of another thing, and is a part of some compound. As the soul, a hand, a vein, &c.

Substance is divided into *material* and *immaterial*. A body is a substance made up of matter and form, and is the object of a particular science, *viz natural philosophy*, by which it is divided into *simple* and *mix'd*, *animate* and *inanimate*, &c. Spirit is a *substance* void of matter and form, and is the object of *pneumaticks*.

Accident is a being inhering in a substance. *Accident* is either *entitive* or *modificative*. *Entitive* is either *primary* or *secundary*: *primary* is *absolute*, as *quantity* and *quality*; or *respective*, as *relation*. *Secundary action*, passion. *Modificative accidents* are, *quando*, *ubi*, *situs*, *habitus*.

Quantity is either *continu'd* or *divided*. Continued *quantity*, which properly belongs to this place, is whose parts are join'd together by a common term.

Divided quantity is that, whose parts are not linked together by a common term, but are divided. *Divided quantity* is number, which may be defin'd, a multitude compos'd of units.

Quantity is an accident, by which material substance is extended.

The species of continu'd *quantity* are a *line*, a *superficies*, and a *body*; for *quantity* is extended either into bare *longitude*, and then it is call'd a *line*, not a material one, but such an one as the mind can frame by idea; or else it is extended into *longitude* and *latitude*, and that is called a *superficies*; or else into *longitude*, *latitude*, and *profundity*, and that makes a mathematical body, which is not to be understood as if it were a corporeal *substance*.

Quality is an *accident*, which influences its subject after the manner of an essential form. There are four *species*, or kinds of it. *Habit* (and *disposition*,) *natural power* and (*weakness*;) *passion*; *figure or form*.

Habit is a *quality* superadded to a natural power, which makes it very readily and easily perform its operations. *Disposition* is an imperfect *habit*, or a *habit* just begun.

Natural power is a *quality* rooted in our very nature which renders a subject fit to do or suffer any thing. *Weakness* is a diminutive power.

Passion is a *quantity*, which affects the senses and the sensitive appetite, but is quickly over.

Figure or *form* is the outward determination and disposition of *quantity*, as roundness.

Relation is an accident, by which one thing is referr'd to another.

Action is an *accident*, by which a thing is said to act. It is either *immanent* or *transient*. *Immanent*, which does not go from the agent to another subject; as *understanding*, *thinking*, *meditating*.

Transient, which goes from one subject to another, as *beating*.

Passion is the receiving of *action*. *Passion* is either *perfective*, by which the subject receives some additional perfection, as, *to be inform'd*: or *corruptive*, by which the patient is either wholly, or in part corrupted, as, *to be wounded*.

Quando is the duration of a being in time.

Ubi is the presence of a being in a place.

Situs is the respect of the parts of the body to a place.

Habitus is the application of a body to that which is near to it.

This science, however it may seem to have been laboured, is yet capable of being farther improved: but it has many obstacles in its way. If we are short-sighted in *physical* matters, which are nearer our sense, and in a manner within our view, how much more must we be bewildered in our search after spiritual abstracted truths, in the consideration of universals, and of things of a transcendant nature, such as fall properly under the consideration of *metaphysicks*.

This science proceeds in unfrequented and almost unknown paths, containing very few doctrines of allowed and established certainty; few principles, in which men are universally agreed; scarce any just definition, any exact and complete division; and consequently affords large matter for doubts and disputes. For though *metaphysical* truths may be certain enough in their own nature, yet they are not usually so to us; but being abstruse things and lying deep and remote from sense, it is not every one that is capable of understanding them and there are fewer yet who understand their true use.

Aristotle

Ariſtotle ſeems to have been the firſt founder and inventor of this abſtracted method of reaſoning, and the conſideration of immaterial beings: for his predeceſſors in philoſophy, ſcarce delivered any thing that was good and ſolid upon theſe ſubjects; and, indeed, antiquity affords nothing upon it compoſed with ſo much ſtrength of reaſon as *Cicero*'s book of the Nature of the Gods. We have but few modern works of this kind, the chief of which are *Deſcartes*, *Mallebranch*, Dr. *Willis*, *Locke*, *S. Graveſande*, Dr, *Moor*, Biſhop *Butler*, *&c.*

METEOROLOGY.

METEOROLOGY is the doctrine of *meteors*; explaining their origin, formation, kinds, phænomena, *&c.*

METEOR is an imperfect mixt, conſiſting of ſublimated exhalations, and formed in the ſuperior region of the air, or of our *atmoſphere*.

There are three kinds of *meteors*, viz. *igneous*, or *fiery*; *aerial*, or *airy*: and *aqueous*, or *watery meteors*.

Igneous, or *fiery* METEORS, ſuch as *lightning*, *thunder*, *ignis fatuus*, *draco volans*, *falling ſtars*, and the like, ſeem to be nothing elſe but ſulphureous and nitrous exhalations, ſet on fire in the air, by the violent motion of the parts. Therefore, the matter of *thunder* and *lightning*, as well as that of gun-powder, is particularly nitre and ſulphur: the effects of both being entirely ſemblable. For the hollow cloud, wherein the ſulphurous and nitrous exhalation is contained, is like the cannon, and the exhalation like the gun-powder; which, when it lacerates the cloud, produces *thunder* and *lightning*. *Thunder*, according to the manner the matter kindled, falls on the earth; whether in a direct or oblique line; and lightning or fulguration, when it blazes through the air, but it cannot break the cloud, with a great violence, without making a very great noiſe: for *thunder* is a ſound, occaſioned by a violent commotion of the ſubtile matter, iſſuing out of a lacerated cloud.

Sir *Iſaac Newton* is of opinion, that *thunder* is not occaſioned by the falling of clouds, but by the kindling of ſulphureous exhalations, in the ſame manner as the noiſe of *aurum fulminans*.

He ſays, that there are ſulphureous exhalations, always aſcending into the air when the earth is dry; there they ferment with the nitrous acids, and ſometimes taking fire, generate *thunder*, *lightning*, &c.

That beſides the vapours raiſed from water, *&c.* there are alſo exhalations carry'd off from ſulphur, bitumen, volatile ſalts, *&c.* is paſt all doubt; the vaſt quantity of ſulphureous and bituminous matter all over the ſurface of the earth, and the volatile ſalts of plants and animals, afford ſuch an ample ſtock thereof, that it is no wonder the air ſhould be filled with ſuch particles (ſay thoſe who eſpouſe Sir *Iſaac*'s opinion) raiſed higher or lower, according to their greater or leſſer degree of ſubtility and activity, and more copiouſly ſpread in this or that quarter, according to the direction of the winds, *&c.*

If what we call *lightning*, acts with extraordinary violence, and breaks or ſhatters any thing, it is called a *thunder-bolt*, which the vulgar, to fit it for ſuch effects, ſuppoſe to be a hard body, and even a ſtone.

The phænomena of the *thunder-bolt* are, that it oftner ſtrikes on high places, than on low: that it often burns people's cloaths, without touching their bodies; as it happen'd to *Amurath* IV. Emperor of the *Turks*, who, while aſleep, in an afternoon, had his ſhirt burnt by thunder, and his body not in the leaſt touch'd: that it ſometimes breaks their bones without hurting their fleſh or their cloaths: that it has even melted the ſword without injuring the ſcabbard, *&c.*

On medals when the *thunder-bolt* is found to accompany the *Emperor*'s heads, (as that of *Auguſtus*) it is a mark of ſovereignty, and of a power equal with the gods.

Appian informs us, that the *thunder-bolt* was the principal divinity of *Seleucia*; adding that it was adorned even in his time, with various hymns and ceremonies.

IGNIS FATUUS is a popular *meteor*, chiefly ſeen in dark nights, frequenting meadows, marſhes, and other moiſt places.—Known among the people by the appellations, *Will with a Wiſp*, and *Jack with a Lanthorn*. It ſeems to ariſe from a viſcous exhalation, which being kindled in the air, reflects a ſort of thin flame in the dark without any ſenſible heat. It is found flying along rivers, hedges, *&c.* becauſe it there meets with a ſtream of air to direct it.

DRACO VOLANS is a fat, heterogeneous, earthy *meteor*, appearing long and ſinuous, ſomething in the ſhape of a *flying dragon*. This ſhape is ſuppoſed to ariſe from the hind part of the matter of this meteor being fired with greater impetuoſity, than what comes firſt out of the cloud; and it is ſuppoſed the broken parts of the cloud, and the ſulphureous

matter, which adheres to them, forms the apparent wings of this imaginary dragon.

The *aerial*, or *airy meteors*, conſiſt of flatulent and ſpirituous exhalations; ſuch are *winds*, *whirl-winds*, and *hurricanes*.

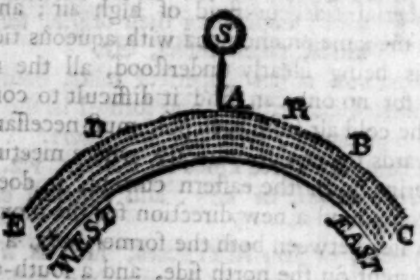
Wind is a ſenſible agitation of the air, whereby a large quantity thereof flows out of one place, or region into another.

As the air is a fluid, its natural ſtate is that of reſt, which it endeavours always to keep or retrieve by an univerſal equilibrium of all its parts. When, therefore, this natural equilibrium of the atmoſphere happens by any means to be deſtroyed in any part, there neceſſarily follows a motion of all the circumjacent air towards that part, to reſtore it; and this motion of the air is what we call *wind*.

Hence, with reſpect to that place where the equilibrium of the air is diſturbed, we ſee the wind may blow from every point of the compaſs at the ſame time; and thoſe who live northwards of that point, have a north wind; thoſe who live ſouthwards, a ſouth wind; and ſo of the reſt: but thoſe who live on the ſpot, where all theſe winds meet and interfere, are oppreſſed with turbulent and boiſterous weather, whirl-winds, and hurricanes; with rain, tempeſt, lightning, thunder, *&c.* For ſulphureous exhalations from the ſouth, torrents of nitre from the north, and aqueous vapours from every part, are there confuſedly huddled, and violently blended together, and rarely fail to produce the phænomena above-mentioned.

Many are the particular cauſes, which produce wind by interrupting the equipoiſe of the atmoſphere; but the moſt general cauſes are two, *viz.* *heat*, which, by rarefying the air, makes it lighter in ſome places than it is in others; and *cold*, which, by condenſing it, makes it heavier. Hence it is, that in all parts over the torrid zone, the air being more rarefied by a greater quantity of the ſolar rays, is much lighter than in the other parts of the atmoſphere, and moſt of all over the equatorial parts of the earth. And ſince the parts at the equator are moſt rarefied, which are near the ſun; and thoſe parts are, by the earth's diurnal rotation eaſtward, continually ſhifting to the weſt; it follows, that the parts of the air which lie on the weſt ſide of the point of the greateſt rarefaction, and, by flowing towards it, meet it, have leſs motion than thoſe parts on the eaſt ſide of the ſaid point, which follow it; and therefore the motion of the eaſtern air would prevail againſt that of the weſtern air, and ſo generate a continual eaſt-wind, if this were all the effect of that rarefaction. But we are to conſider, that as all the parts of the atmoſphere are ſo greatly rarefied over the equator, and all about the poles greatly condenſed by extreme cold, this heavier air from either poles is conſtantly flowing towards the equator, to reſtore the ballance deſtroyed by the rarefaction and levity of the air over thoſe regions; hence, in this reſpect alone, a conſtant north and ſouth wind would be generated.

To illuſtrate the cauſe of this perpetual current of air from eaſt to weſt, or of a conſtant *eaſt-wind* under the *equator*, I ſhall add this Figure.



Let C B A D E be part of a ſection of the atmoſphere over the equator, C the eaſt, E the weſt, A the point to which the ſun S is vertical, and R the point of greateſt rarefaction, or that where the air is moſt of all heated, and, conſequently, lighteſt. And, becauſe the air at R is by ſuppoſition lighter than where it is colder at C and D, it is plain that in order to obtain an equilibrium (which is neceſſary in a fluid body) the air by its greater weight will have a tendency from C and D towards R, and riſe to a height there greater than at C or D, in proportion as its denſity is leſs.

This being the caſe, it is evident, the ſun, being always between the points R and D, will be heating the air on that part; and thoſe regions between R and C, having been deſerted by the ſun, will grow cold; conſequently, the air between C and R, as it is colder, will likewiſe be heavier than that between R and D which is hotter, and ſo will have a greater momentum, or quantity of motion, towards the point R; and ſince this point R is conſtantly moving after the point A weſtward, the motion of the weſtern air towards it, will be in part diminiſhed by that means; and being alſo inferior in quantity to the motion of the eaſtern air, the latter will prevail over it, and be conſtantly following the ſaid point R from eaſt to weſt, and thus produce a continual eaſt wind.

It may, perhaps, be here ſaid, that though the motion of the air be leſs from D to R, yet it is ſomething, and ſo there ought to be a weſtern wind, at leaſt in ſome degree, and to ſome diſtance weſtward of the point R. To which we anſwer, that the nature of a fluid will not permit two contrary

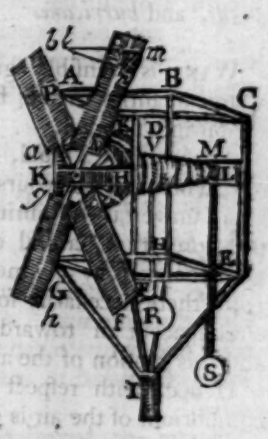
trary motions to reſtore or ſuſtain an equilibrium (we mean in regard of the whole body of it) for wherever one part of the fluid is determined to move, all the reſt muſt neceſſarily follow it; otherwiſe the equilibrium of the air would be deſtroyed in one part to make it good in another a defect which nature cannot be guilty of. Thus, we ſee the tides of the ocean always follow the courſe of the moon from eaſt to weſt, without any motion of the waters from the weſt towards the moon, in the open oceans; and the point R can only be conſidered as the aerial tide, or fluid of high air; and has nearly the ſame phænomena with aqueous tides.

This being clearly underſtood, all the reſt is eaſy; for no one can find it difficult to conceive how the cold air from each pole muſt neceſſarily ſet in towards the equator directly, where meeting and interfering with the eaſtern current, it does with that compound a new direction for the moving air which lies between both the former, *viz.* a north-eaſt current on the north ſide, and a ſouth-eaſt on the ſouth ſide: all which naturally reſults from the doctrine of the compoſition of oblique forces.

And this we find to be verified in the general trade-winds, which conſtantly blow from the north-eaſt and ſouth-eaſt, to about thirty degrees on each ſide the equator, where thoſe parts are over the open ocean, and not affected with the reflection of the ſun-beams from the heated ſurface of the land; for in this caſe the wind will always ſet in upon the land, as on the coaſt of *Guinea*, and other parts of the torrid zone, we know it does.

Velocity and force of the WIND. As the motion of the air has a greater or leſſer velocity, the wind is ſtronger or weaker; and it is found from obſervation, that the velocity of the wind is various, from the rate of 1 to 50 or 60 miles *per* hour. The beſt way to prove this, is to chuſe a free open place, where the wind or current of air is not at all interrupted, but flows uniformly, or as much ſo as the undulatory ſtate of the atmoſphere will admit: in ſuch a place, a feather, or other very light body, is to be let go in the wind; and then, by a half-ſecond watch, or pendulum, you muſt obſerve nicely to what diſtance it is carried in any number of half-ſeconds, or in how many half-ſeconds it has paſſed over a given or meaſured ſpace. This will give the rate of velocity in the wind *per* ſecond, and of courſe *per* hour; which has been found, at a medium, to be 12 or 15 miles *per* hour: even the moſt vehement wind does not fly above 50 or 60 miles *per* hour; and ſometimes the wind is ſo ſlow as not to exceed the velocity of a perſon riding or walking in it; and in that caſe, if the perſon goes with the wind, he finds no wind at all, becauſe there is no difference of velocity, or no relative wind, which is that only which we are ſenſible of, whilſt in motion.

The method to eſtimate the force of wind preciſely, is to try it by the following *Anemometer*.



ABCDEFGHI is an open frame of wood, firmly ſupported by the ſhaft or poſtern I. In the croſs-pieces HK, LM, is moved an horizontal axis QM, by means of the four ſails *ab*, *cd*, *ef*, *gh*, in a proper manner expoſed to the wind. Upon this axis is fix'd a cone of wood MNO, upon which, as the ſails move round, a weight S, is raiſed, by a ſtring on its ſuperficies, proceeding from the ſmall to the largeſt end NO. Upon the great end or baſe of the cone is fixed a ratchet-wheel *i k*, in whoſe teeth falls the click X, to prevent any retrograde motion from the depending weight.

From the ſtructure of this machine, it is eaſy to underſtand, that it may be accommodated to eſtimate the variable force of the wind, becauſe the force of the weight will continually increaſe, as the ſtring advances on the conical ſurface, by acting at a greater diſtance from the axis. And therefore, if ſuch a weight be put on, on the ſmalleſt part at M, as will juſt keep the machine in equilibrio with the weakeſt wind; then, as the wind becomes ſtronger, the weight will be raiſed in proportion, and the diameter of the baſe of the cone NO, may be ſo large in compariſon of that of the ſmaller end or axis at M, that the ſtrongeſt wind ſhall but juſt raiſe the weight to the great end.

Thus, for example, let the diameter of the axis be to that of the baſe of the cone NO, as 1 to 28, then if S be a weight of 1 pound at M, on the axis, it will be equivalent to 28 pounds, or $\frac{1}{4}$ of an hundred, when raiſed to the greateſt end. If, therefore, when the wind is weakeſt, it ſupports 1 pound on the axis, it muſt be 28 times as ſtrong to raiſe the weight to the baſe of the cone. Thus may a line of 28 equal parts be drawn on the ſide of the cone, and the ſtrength of the wind will be indicated by that number on which the ſtring ſhall at any time hang.

The ſtring may alſo be of ſuch a ſize and the cone of ſuch a length, that there may be ſixteen revolutions of the ſtring betwixt each diviſion of the ſcale on the cone, whence the ſtrength of the wind will be expreſſed in pounds and ounces. And

if

of greater exactneſs be required, let the periphery of the cone's baſe be divided into 16 equal parts; then, whenever the equilibrium happens, the ſtring will leave the conic ſurface againſt one of thoſe diviſions, and thus ſhew the force of the wind to a dram avoirdupoiſe weight.

As to *the qualities and effects of the* wind.—1. A *wind* blowing from the ſea is always moiſt; in ſummer it is cold, and in winter warm, unleſs the ſea be frozen up.

2. *Winds* blowing from the continent, are always dry; in ſummer warm, and cold in winter.

The *winds* are divided into *perennial*, *ſtated*, and *variable*.—They are alſo divided into *general* and *particular*.

Perennial, or *conſtant winds*, are ſuch as always blow the ſame way. Of theſe we have a very notable one between the two tropicks, blowing conſtantly from eaſt to weſt; called the *general trade wind*.

Stated, or *periodical winds*, are ſuch as conſtantly return at certain times. Such are the ſea and land breezes, blowing from land to ſea in the evening, and from ſea to land in the morning: though this rule is not general.

Such are alſo the *ſhifting*, or *particular trade winds*, which for certain months of the year, blow one way, and the reſt of the year, the contrary way.

Variable, or *erratick winds*, are ſuch as blow, now this, now that way.

Such are all the *winds* obſerved in the inland parts of *England*, &c. though ſeveral of theſe claim their certain times of the day. Thus the *weſt wind* is moſt frequent about noon; the *ſouth wind* in the night; the *north* in the morning, &c.

General wind, is ſuch a one, as, at the ſame time, blows the ſame way, over a very large tract of land, almoſt all the year. But even this has its interruptions: for, 1. At land it is ſcarce ſenſible at all, as being broke by the interpoſition of mountains, valley, &c. 2. At ſea, near the ſhore, it is diſturbed by vapours, exhalations, and particular *winds*, blowing from landward; ſo that it is chiefly conſidered as general only at mid-ſea: where, 3. It is liable to be diſturbed, by clouds driving from other quarters.

Particular winds include all others, excepting the general *trade winds*. Thoſe peculiar to one little cantoon, or part, are called *topical* or *provincial winds*.——Such is the north *wind*, on the weſtern ſide of the *Alps*, which does not blow above one or two leagues lengthwiſe, and much leſs in breadth: ſuch alſo are the *Pontia's* in *France*, &c.

Whirl-wind *is* a *wind* that riſes ſuddenly, is exceedingly rapid, and impetuous when riſen, but ſoon ſpent.

There are divers ſorts of *whirl-winds*, diſtinguiſhed by their peculiar names; as the *preſter*, *typho*, *echnephias*, *exhydria*, and *turbo*.

The *preſter* is a violent *wind*, breaking forth with flaſhes of lightning.

The *echnephias* is a ſudden and impetuous *wind*, breaking out of ſome cloud, frequent in the *Ethiopick* ſea, particularly about the cape of *Good Hope*.—The ſeamen call them *tornados*.

The *exhydria* is a *wind* burſting out of a cloud, with a great quantity of water.

A *typho*, or *vortex*, moſt properly called a *whirl-wind*, or *hurricane*, is an impetuous *wind*, turning rapidly every way, and ſweeping all around the place.—It is frequently in the eaſtern ocean, about *Siam*, *China*, &c.

Hurricane, a furious ſtorm of *wind*, ariſing from a contrariety or oppoſition of ſeveral *winds*.

They begin in the north, ſome ſay, in the weſt, but turn round; and in a little time are through all the points of the compaſs.

All *hurricanes* come either on the day of the full, change, or quarter of the moon; each of which is diſcover'd by a number of phænomena, the preceding quarters, as a turbulent ſky, ſun red, univerſal calm, the ſtars appearing red, noiſes in hollows, or cavities of the earth, ſtrong ſmell of the ſea, a ſettled weſterly wind, &c.

The *aqueous* or *watery* Meteors, are compoſed of vapours or watery particles, variouſly ſeparated and condenſed by heat and cold; ſuch are *clouds*, *rainbows*, *hail*, *ſnow*, *rain*, *dew*, and the like.

Cloud is a collection of condenſed vapours, ſuſpended in the atmoſphere, the particles whereof, collected together, intercept almoſt the whole heat of the ſun, whence thoſe who inhabit the higheſt mountains of the *Pyrenees*, or of the *Alps*, when they are arrived at the region of the *clouds*, are not inſenſible of their entring a thick and opake *cloud*.

Aura Serotina, or *evening-dew*, is a *penetrating vapour*, which exalted together with the vapours, by the diurnal heat of the ſun, falls ſoon after ſun-ſet.

The Morning Dew is a thin, light, inſenſible miſt, or rain, falling while the ſun is below the horizon.—Among the diſſertations of M. *Huet*, is a letter, to ſhew that *dew* does not fall, but riſes.

May-Dew whitens linen and wax; the *dew* of autumn is converted into a white froſt. Out of *dew*, putrified by the ſun, ariſes divers inſects, which change apace from one ſpecies into another. What remains is converted into a fine white ſalt, with angles like thoſe of ſalt-petre, after a number of evaporations, calcinations, and fixations.

There

There is a ſpirit drawn from *May-dew*, which has wonderful virtues attributed to it. It is to be gather'd in clean linen cloths, expoſed to the ſun in cloſe vials. *Stolterfold*, a Phyſician of *Lubeck*, thinks *May-dew* may be gather'd in glaſs plates, eſpecially in ſtill weather, and before ſun-riſe. It may likewiſe be collected with a glaſs-funnel, expoſed to the air, having a crooked neck to bring the *dew* into a vial in a chamber.

RAIN is form'd of the concretion of vapours, and deſcending from above in form of drops of water.

But the agent of this formation of the clouds into *rain*, &c. is a little controverted: the common *Peripateticians* will have it, the cold, which conſtantly occupying the ſuperior region of the air, chills and condenſes the veſiculæ, at their arrival from a warmer quarter, congregates them together, and occaſions ſeveral of them to coaleſce into little maſſes: by this means their quantity of matter increaſing in a greater proportion than their ſurface, they become an over load to the thin air, and accordingly deſcend in rain.

Mr. *Derham* accounts for the precipitation, hence; that the veſiculæ being full of air, when they meet with a colder air than that they contain, the air is contracted into a leſſer ſpace, and conſequently the watery ſhell or caſe render'd thicker, ſo as to become heavier than the air, *&c.*

Others only allow the cold a part in the action, and bring in the winds as ſharers with it.

Yet, the grand cauſe, according to *Rohault*, is ſtill behind; that author conceives it to be the heat of the air, which after continuing for ſome time near the earth, is at length carried up on high by a wind, and there thawing the ſnowy villi, or flakes of the half-frozen veſiculæ, reduces them into drops, which coaleſcing, deſcend, and have their diſſolution perfected, in their progreſs through the lower and warmer ſtages of the atmoſphere.

Others, as Dr. *Clark*, &c. aſcribe this deſcent of the clouds, rather to an alteration of the atmoſphere, than of the veſiculæ, and ſuppoſe it to ariſe from a diminution of the ſpring or elaſtick force of the air.

This elaſticity, which depends chiefly or wholly on the dry terrene exhalations being weakened, the atmoſphere ſinks under its burden, and the clouds fall on the common principle of precipitation.

As to the *quantity of rain* that falls, its proportion in ſeveral places at the ſame time, and in the ſame place at ſeveral times, we have ſtore of obſervations, journals, *&c.* in the memoirs of the *French* Academy, the *Philoſophical tranſactions*, &c. an idea whereof will not be unacceptable.

Upon meaſuring then, the *rain* falling yearly, its depth at a medium, is found as in the following tables.

Depth of the Rain *in* falling yearly, *and its proportion in ſeveral places.*

At *Paris*, in *France*, obſerv'd by M. *de la Hire*	19 *Inch.*
At *Liſle*, in *Flanders*, by M. *Vauban*	24
At *Piſa*, in *Italy*, by Dr. *Mich. Ang. Tilli*	43 $\frac{1}{2}$
At *Townly*, in *Lancaſhire*, by Mr. *Townly*	42 $\frac{1}{2}$
At *Upminſter*, in *Eſſex*, by Mr *Derham*	19 $\frac{1}{2}$
At *Zurich*, in *Switzerland*, by D. *Scheuchzer*	52 $\frac{1}{2}$

Proportion of the Rain *of* ſeveral Years *to one another.*

At PARIS.			At UPMINSTER.	
21 *Inch.*	38 *cent.*	1700	19 *Inch.*	03 *cent.*
27	78	1701	18	69
17	42	1702	20	38
18	51	1703	23	99
21	20	1704	15	81
14	82	1705	16	93

Proportions of the Rain *of the* ſeveral ſeaſons *to one another.*

1708	*Depth at* Piſa.	*Depth at* Upminſt.	*Depth at* Zurich.	1708	*Depth at* Piſa.	*Depth at* Upminſt.	*Depth at* Zurich.
	Inch.	*Inch.*	*Inch.*		*Inch.*	*Inch.*	*Inch.*
Jan.	6 41	2 88	1 64	*July*	0 00	1 11	3 50
Febr.	3 28	0 46	1 65	*Aug.*	2 27	2 94	3 15
March	2 65	2 03	1 51	*Sept.*	7 21	1 46	3 02
April	1 25	0 96	4 69	*Octob.*	5 33	0 23	2 24
May	3 33	0 02	1 91	*Nov.*	0 13	0 86	0 62
June	4 90	2 32	5 91	*Dec.*	0 00	1 97	2 62
half-year	28 82	10 67	17 31	*half year*	14 94	8 57	15 35

Preternatural RAINS, or *ſhowers*, as of blood, *&c.* are very common in our annals, and even natural Hiſtories, yet if ſtrictly pry'd into, will be all found no other things than *rain*.

SNOW, *nix*, ſeems to be nothing elſe but a meteor formed in the middle region of the air; of vapours raiſed by the action of the ſun or ſubterraneous fire, there congealed, its parts conſtipated, its ſpecifick gravity increaſed, and thus returned to the earth in form of little white villi or flakes.

The *ſnow* we receive may properly enough be aſcribed to the coldneſs of the atmoſphere, through which it falls. When the atmoſphere is warm enough to diſſolve the *ſnow* before it arrives at us, we

we call it *rain*; if it preserves itself undissolved, it makes what we call *snow*.

Dr. *Grew*, in a discourse on the nature of *snow*, observes, that many parts thereof are of a regular figure, for the most parts are so many little rowels or stars of six points, and are perfect and transparent ice, as any we see on a pond, *&c.* Upon each of these points are other collateral points set at the same angles as the main points themselves: among which there are divers other irregular troops, which are chiefly broken points, and fragments of the regular ones.

But when the little clusters or flakes of the congealed vapour, are liquified by a warm air, and meet afterwards in their descent with a colder air, they are then changed into *hail*, whose grains acquire a different figure, according to the different solutions of the flakes. Sometimes it is round, sometimes angular, triangular, pyramidal, *&c.* sometimes thin and flat, star-like, with six equal points, *&c.*

Hail is observed frequently to attend thunder and lightning; the nitre that contributes to the one, having likewise a large share in the production of the other.

Natural Histories furnish us with various instances of extraordinary showers of *hail*.

From these I'll pass to the rainbow, and other *amphatical* impressions, as the *halo*, *parelium*, and *paraselene*.

The Rainbow is a meteor in form of a party-coloured arch or semicircle, exhibited in a rainy sky, opposite to the sun, by the refraction of its rays in the drops of falling rain.

There is also a secundary or fainter *rainbow*, usually seen investing the former at some distance; and among naturalists we read of lunar *rainbows*, marine *rainbows*, &c.

The *rainbow*, Sir *Isaac Newton* observes, never appears, but where it rains in the sun-shine, and may be represented artificially, by contriving waters to fall in little drops like rain, through which the sun shining, exhibits a *bow* to the spectator, placed between the sun and the drops; especially if a dark body, *e. gr.* a black cloth be disposed beyond the drops.

To conceive the origin of the *rainbow*, we must consider what will befal rays of light, coming from a very remote body, *e. gr.* the sun; and falling on a globe of water, such as we know a drop of rain to be.

Suppose than A D K N, See *table* of Optics, *Fig.* 12. to be a drop of rain, and the lines E F, B A, O N, to be rays of light coming from the center of the sun; which by reason of the immense distance of the sun, we conceive to be parallel. Now the ray B A being the only one that falls perpendicularly on the surface of the water, and all the rest obliquely; it is easily inferred, that all the other rays will be refracted towards the perpendicular.

Thus the ray E F, and others accompanying it, will not go on strait to G; but as they arrive at H I, deflect from F to K, where some of them, probably, escaping into the air, the rest are reflected upon the line K N, so as to make the angles of incidence and reflection equal.

Farther, as the ray K N, and those accompanying it, fall obliquely upon the surface of the globule; they cannot pass out into the air, without being refracted, so as to recede from the perpendicular L M; and therefore will not proceed strait to Y, but deflect to P.

It may be here observed, that some of the rays arriving at N, do not pass out into the air, but are again reflected to Q; where being refracted like the rest, they do not proceed right to Z, but declining from the perpendicular T V, are carried to R; but since we here only regard the rays, as they may affect the eye, placed a little below the drop, *e. gr.* at P, those which deflect from N to Q, we set aside as useless, because they never come at the eye. On the contrary, it is to be observed, that there are other rays, as 2, 3, and the like; which being reflected from 3 to 4, thence to 5, and from 5 to 6, may at length arrive at the eye placed beneath the drop.

Thus much is obvious; but to determine precisely the quantities of refraction of each ray, there must be a calculation; by such calculation it appears, that the rays which fall on the quadrant A D; are continued in lines, like those here drawn in the drop A D K N; wherein there are three things very considerable: *First*, that the two refractions of the rays in their ingress and egress, are both the same way, so that the latter does not destroy the effect of the former. *Secondly*, that of all the rays passing out of A N, N P, and those adjoining to it, are the only ones capable of affecting the sense; as being sufficiently close or contiguous; and because coming out parallel; whereas the rest are divaricated, and dispersed too far to have any sensible effect, at least to produce any thing so vivid as the colours of the *bow*. *Thirdly*, that the ray N P has shade or darkness under it; for since there is no ray comes out of the surface N 4, it is the same thing as if the parts were cover'd with an opake body. We might add, that the same ray N P, has darkness above it; since the rays that

are

are above it are ineffectual; and ſignify no more than if there were none at all.

Add to theſe, that all the effectual rays have the ſame point of reflection, *i. e.* the parallel and contiguous rays, which alone are effectual after refraction, will all meet in the ſame point of the circumference; and be reflected thence to the eye.

Farther it appears by calculation, that the angle ONP, included between the ray NP, and the line ON, drawn from the center of the ſun, which is the angle whereby the *rainbow* is diſtant from the oppoſite point of the ſun, and which makes the *ſemidiameter of the bow*, contains 41° 30′.

But ſince, beſides thoſe rays coming from the center of the ſun to the drop of water, there are many more from the ſeveral points of its ſurface: there are a great many other effectual rays to be conſidered; eſpecially that from the uppermoſt, and that from the loweſt part of the ſun's body.

Since then the apparent diameter of the ſun, is about 16 ſeconds, it follows that an effectual ray from the upper part of the ſun, will fall higher than the ray EF, by 16 ſeconds: this does the ray GH, *Fig.* 13. which being refracted as much as EF, deflects to I, then to L, and at length emerging equally refracted with the ray NP, proceeds to M; and makes an angle ONM, of 41°, 14′, with the line ON.

In like manner the effectual ray QR, coming from the loweſt part of the ſun, falls on the point R, 16 min. lower than the point F, on which the ray EF falls; and being refracted declines to S; whence it is reflected to T; where emerging into the air, it proceeds to V; ſo as the line TV, and the ray OT, contain an angle of 41°, and 46′.

Again, upon computing the deflections of the rays, which like that 23, *Fig.* 14. coming from the center of the ſun, and being received into the lower part of the drop, we have ſuppoſed to be twice reflected, and twice refracted, and to enter the eye like that 67, *Fig.* 16. we find that which may be accounted effectual, as 67, with the line 86, drawn from the center of the ſun, contains an angle 867, of about 62 degrees: whence it follows, that the effectual ray from the higheſt part of the ſun, with the ſame line 86, includes an angle leſs by 16 min. and that from the loweſt part of the ſun, an angle greater by 16 min.

Thus ſince ABCDEF, is the path of the efficacious ray, from the higheſt part of the ſun to the eye in F; the angle 86 F becomes of about 51°, 44′. In like manner, ſince GHIKLM is the way of an effectual ray from the loweſt part of the ſun to the eye, the angle 86 M, becomes nearly of 52°, 16′.

Since then we admit ſeveral rays to be effectual, beſides thoſe from the center of the ſun; what we have ſaid of the ſhade, will need ſome alteration: for of the three rays deſcribed, *Fig.* 12, and 13. only the two extreme ones will have a ſhadow joined to them, and that only on the outer ſide. Hence it is evident, that theſe rays are perfectly diſpoſed to exhibit all the colours of the priſm.

For the great quautity of denſe or intenſe light, *i. e.* the bundle of rays collected together in a certain point, *v. gr.* in the point of reflection of the effectual rays, may be accounted as a livid or radiant body, terminated all around by ſhade. But the ſeveral rays thus emitted to the eye are both of different colours, and are differently refracted out of the water into air, notwithſtanding their falling alike upon the refracting ſurface.

Hence it follows, that the different or heterogeneous rays will be ſeparated from one another, and will tend ſeveral ways; and the homogeneous rays will be collected, and tend the ſame way; and therefore this livid point of the drop wherein the refraction is effected, will appear fringed or bordered with ſeveral colours; that is, red, green, and blue colours will ariſe from the extreams of the red, green, and blue rays of the ſun tranſmitted to the eye from ſeveral drops, one higher than another; after the ſame manner as is done in viewing livid, or other bodies through a priſm.

Thus, adds Sir *Iſaac Newton*, the rays that differ in refrangibility, * will emerge at different angles; and conſequently, according to their different degrees of refrangibility, emerging moſt copiouſly at different angles, will exhibit different colours in different places.

A great number then of theſe little globules being diffuſed in the air, will fill the whole place with theſe different colours; provided they be ſo diſpoſed, as that effectual rays may come from them to the eye; and thus will the *rainbow* at length ariſe.

Now to determine what that diſpoſition muſt be; ſuppoſe a right line drawn from the center of the ſun, through the eye of the ſpectator, as the line VX, *Fig.* 13. called the line of aſpect; being drawn from ſo remote a point, it may be eſteemed parallel to all other lines drawn from the ſame point: but a right line falling on two paral-

* *Refrangibility* of light is the diſpoſition of the rays to be refracted. That a *greater* or *leſs refrangibility*, is a diſpoſition to be more or leſs refracted, in paſſing at equal angles of incidence, into the ſame medium.

lels, makes the alternate angles. If then an indefinite number of lines be imagined drawn from the spectator's eye to a part opposite to the sun where it rains; which lines make different angles with the line of aspect, equal to the angle of the refraction of the differently refrangible rays, *e. gr.* angles of 41°, 46′ and of 41°, 30′, and of 41°, 40′. These lines falling on drops of rain illuminated by the sun, will make angles of the same magnitude, with rays drawn from the center of the sun to the same drops. And therefore the lines thus drawn from the eye, will represent the effectual rays that occasion the sensation of any colour. That, *e. gr.* making an angle of 41°, 46′, representing the least refrangible or red rays of the several drops, and of 41°, 40′, the most refrangible or violet rays: the intermediate colours and refrangibilities will be found in the intermediate space.

Now it is known that the eye being placed in the vortex of a cone, sees objects upon its surface as if they were in a circle; and the eye of our spectator is here in the common vortex of several cones, formed by the several kinds of efficacious rays, with the lines of aspect. And in the surface of that whole angle where the vortex or eye is the greatest, and wherein the others are included, are those drops or parts of drops which appear red: and in the surface of that cone whose angle is least, are the purple drops: and in the intermediate cones are the green, blue, &c. drops. Hence then several kinds of drops must appear as if disposed into so many circular colour'd fasciæ or arches, as we see in the *rainbow*.

This part of the solution, Sir *Isaac Newton* expresses more artfully, thus: Suppose O, *Fig.* 15. *optic.* the eye, and O P a line parallel to the sun's rays, and let P O E, P O F be angles of 40°, 17′, and 42°, 2′. And suppose the angle to turn about their common side O P, with their other sides O E and O F, they will describe the bounds or verges of the *rainbow*.

For if E F, be drops placed any where in the conical surface described by O E, O F; and be illuminated by the sun's rays S E, S F, the angle S E O being equal to the angle P O E or 40° 17′ shall be the greatest angle in which the most refrangible rays come after reflection be refracted to the eye; and therefore all the drops in the line O E, shall send the most refrangible rays most copiously to the eye, and thereby strike the senses with the deepest violet colour in that region.

And in like manner the angle S F O being = to the angle P O F = 420° 2′ shall be the greatest, in which the least refrangible rays, after one reflection, can emerge out of the drops; and these rays shall come most copiously to the eye from the drops in the line O F, and strike the senses with the deepest red colour in that region.

And by the same argument the rays, which have intermediate degrees of refrangibility, shall come most copiously from drops between E and F, and so strike the senses with the intermediate colours, in the order which their degrees of refrangibility require; that if the progress from E to F, or from the inside of the bow to the outside, in this order, *violet, indico, blue, green, yellow, orange, red*; though the violet, by the mixture of the white light of the clouds will appear faint, and incline to a purple.

And since the lines O E, O F may be situated any where in the abovementioned conical surface; what is said of the drops and colours in these lines is to be understood of the drops and colours throughout the whole superficies. Thus is the primary or *inner bow* formed.

As to the *secundary* or *fainter bow*, usually surrounding the former; in assigning what drops would appear coloured, we exclude such as lines drawn from the eye, making angles a little greater than 40° 2′ should fall upon; but not such as should contain angles much greater.

For, if an indefinite number of such lines be drawn from the spectator's eye, some whereof make angles of 50° 57′ with the line of aspect *e. gr.* O G, otherwise angles of 54° 7′ *e. gr.* O H; those drops whereon these lines fall, must of necessity exhibit colours, particularly those of 50° 57′.

E. gr. the drop G, will appear red, the line G O being the same with an effectual ray; which after two reflections and two refractions, exhibits a red colour. Again, those drops which receive lines of 54° 7′ *e. gr.* the drop H will appear purple, the line O H, being the same with an effectual ray, which after two reflections and two refractions, exhibits purple.

Now there being a sufficient number of these drops, it is evident there must be a second *rainbow*, formed after the like manner as the first.

Thus Sir *Isaac Newton*, in the least refrangible rays, the least angle at which a drop can send effectual rays after two reflections, is found by computation to be 50° 57′, and in the most refrangible the least angle is found 54° 7′.

Suppose then O the place of the eye, as before, and P O G, P O H to be angles of 50° 57′ and 54° 7′; and these angles to be turned about their common side O P, with their other sides O G, O H, they will describe the verges or borders of the *rainbow* C H D G.

For

For if GH be drops placed any where in the conical superficies described by OG, OH, and be illuminated by the sun's rays; the angle SGO, being equal to the angle POG or 50° 57′ shall be the least angle, in which the then less refrangible rays shall come most copiously to the eye from the drops in the line OG, and strike the senses with the deepest red in that region.

And the angle SHO, being equal to POH, 54 shall be the least angle, in which the most refrangible rays after two reflections, can emerge out of the drops; and therefore those rays should come most copiously to the eye from the drops in the line OH, and so strike the senses with the deepest violet in that region.

And by the same argument, the drops in the region between G and H shall strike the senses with the intermediate colours, in the order which their degrees of refrangibility require, that is, in the progress from G to H, or from the inside of the bow to the outer, in this order; *red, orange, yellow, green, blue, indico, violet.*

And since the lines OG, OH, may be situated any where in the conical surface; what is said of the drops and colours in those lines, is to be understood of the drops and colours every where in these superficies.

Thus are formed two *bows*, an interior and stronger, by one reflection; and an exterior and fainter by two; the light becoming weaker and weaker by every reflection.

Their colours will lie in a contrary order to one another, the first having the red without, and the purple within; and the second, the purple without and red within, and so of the rest.

This doctrine of the *rainbow* is confirmed by an easy experiment; for upon hanging up a glass globe full of water in the sunshine, and viewing it in such a posture as that the rays which come from the globe to the eye, may with the sun's rays, include an angle either of 42°, or 50°; if, *e. gr.* the angle be about 42°, the spectator supposed at O, will see a full red colour in that side of the globe opposite to the sun, as at F. And if that angle be made a little less, suppose by depressing the globule to E, the other colours, yellow, blue, and green, will appear successively in the same side of the globe, also exceedingly bright.

But if the angle be made about 50°, suppose by raising the globule G, there will appear a red colour in that side of the globe towards the sun, though that somewhat faint; and if the angle be made greater, suppose by raising the globe to H, the red will change successively to the other colours, yellow, green, and blue.

The same thing is observed in letting the globe rest, and raising or depressing the eye to make the angle of a just magnitude. This is called an *artificial rainbow.*

Des Cartes was the first who took the *dimensions of the rainbow*, and determined the diameter thereof, by laying it down, that the magnitude of the *bow* depends on the degree of refraction of the fluid, and assuming the ratio of the sine of incidence to that of refraction, to be in water as 250 to 187.

But Dr. *Halley* has since, in the *Philosophical Transactions*, given us a simple direct method of determining the diameter of the *rainbow* from the ratio of refraction of the fluid being given; or *vice versâ*, the diameter of the *rainbow* being given to determine the refractive power of the fluid. The praxis is as follows.

First, The ratio of refraction being given, to find the angles of incidence, and refraction of a ray which becomes effectual after any given number of reflections. Suppose any given line, as AC (*ibid. Fig.* 17.) which divide in D, so as that AC be to AD, in the ratio of refractions; and again divide it in E, so as AC be to AE, as the given number of reflections increased by what unity is to unity; with the diameter CE describe a semicircle CBE, and from the center A with the radius AD, describe an arch DB intersecting the semicircle in B: then drawing AB, CB, ABC, or its complement to two right angles, will be the angle of incidence, and ACB the angle of refraction required.

Secondly, The ratio of refraction and any angle of incidence being given, to find the angle which a ray of light emerging out of a refracting sphere, after a given number of reflections, makes with the line of aspect, or an incident ray; and consequently to find the diameter of the *rainbow*. The angle of incidence and the ratio of refraction being given, the angle of refraction is given; which angle being multiplied by double the number of reflections increased by 2, and double the angle of incidence subtracted from the product, the angle remaining is the angle sought.

Thus supposing the ratio of refraction to be, as Sir *Isaac Newton* has determined it, *viz.* as 108 to 81, in the red rays, as 109 to 81 for the blue rays, &c. the preceding problem will give the distance of the colours in the

1st Rainbow	Red,	42° 11′	the spectator's back being turn'd to the sun.
	Violet,	40 16	
2d Rainbow	Red,	50 58	
	Violet,	54 9	

If the angle made by a ray after three or four reflections, were required, and therefore the di-

meter of the third and fourth *rainbow* (which are scarce ever seen, by reason of the great diminution of the rays, by so many repeated reflections) they will be found,

3d Rainbow	Red,	41°	37′	the spectator being turned towards the sun.
	Violet,	37	9	
4th Rainbow	Red,	43	52	
	Violet,	49	34	

Hence the *breadth of the rainbows* is easily found: for the greatest semi-diameter of the first *bow*, i. e. from red to red, being 42°, 1′, and the least, *viz.* from violet to violet, 40°, 16′; the breadth of the *fascia* or *bow*, measured a-cross from red to violet, will be 1°, 45′; and the greatest diameter of the second *bow*, being 54°, 9′, and the least 50°, 58′, the breadth of the *fascia* will be 3°, 10′; and hence the distance between the two will be found 8°, 15′.

In these measures the sun is only esteemed a point; wherefore as its diameter is really about 30′, so much must be added to the breadth of each *fascia* or *bow*, from red to violet, and so much be subtracted from the distance between them.

This will leave the breadth of the *primary bow*, 2°, 15′; that of the *secondary bow*, 3°, 40′: and the interval between the two *bows* 8°, 25′; which dimensions deduced from calculation, Sir *Isaac Newton* assures us from his own observations, agree very exactly with those found by actual mensuration in the heavens.

The moon sometimes also exhibits the phenomenon of an *iris* or *bow*; by the refraction of her rays in the drops of rain in the night-time.

Aristotle says, he was the first that ever observed it; and adds, that it never happens, *i. e.* is never visible, but at the time of the full moon.

Halo, called also *corona*, is a *meteor* in form of a luminous ring or circle. It differs from the rainbow in that it is almost always of one colour, and is oftner round the moon than round the sun.

The *halo* is supposed to arise from a refraction of the rays of light in their passing through the fine, rare vesiculæ of a thin nubecula or vapour, towards the top of our atmosphere; which account is confirmed hence, that a quantity of water being thrown up against the sun, as it breaks and disperses into drops, it forms a kind of *hale* or *iris*, exhibiting the colours of the natural ones.

Parelium, or *parhelion*, is a mock sun or meteor, in form of a very bright light, appearing aside of the sun, formed by the reflection of his beams, in a cloud properly posited.

The *parelia* usually accompany the coronæ or luminous circles, are placed in the same circumference, and at the same height. Their colours resemble those of the rainbow, the red and yellow on the side towards the sun, and the blue and violet on the other. Though there are coronæ sometimes seen entire, without any *parelia*; and *parelia* without coronæ.

M. *Des Cartes* is of opinion, *Dissert. ultim. Meteor.* that *parelia* are formed by the sun, painting his image either double or triple, *&c.* in a high circle drawn round a congealed and polished cloud, by means of a reflected or refracted light.

The Paraselene, or *mock moon*, is a meteor or phænomenon encompassing or adjacent to the moon, in form of a luminous ring; wherein is sometimes observed one, sometimes two apparent images of the moon.

The *paraselenes* are formed after the same manner as the *parelia*.

I think it not improper to join to this treatise of the different phænomena, which appear in the *air*, a concise dissertation on those, which appear on *earth*, and particularly on that extraordinary one of the *flux* and *reflux* of the sea.

The Flux and Reflux, or *ebb* and *flow* of the sea, are two periodical motions of the waters of the sea.

Dr. Halley has deduced a theory of the *tides* from the *Newtonian* principles, in the following manner: and says,

1. That as the surface of the earth and sea is naturally globular; if we suppose the moon perpendicularly over the surface of the sea; it is evident, that the water neareſt the moon will gravitate towards it more than any other part of the earth and sea in that hemisphere. That part of the waters therefore must by this means be raised towards the moon, *i. e.* it will be lighter than usual, and therefore will swell there.

For the same reason, the water the most remote from the moon, will gravitate less towards the same, than any other part of the earth or sea in the same hemisphere. The water here, therefore, must approach less towards the moon than any other part of the globe, *i. e.* it must be raised contrariwise, as being lighter than usual, and will therefore swell in that remote part.

By this means, the surface of the ocean must necessarily form itself into a spheroidal or oval figure; having a diameter longer than the other, as already observed in *Des Cartes*'s System. And thus the moon shifting her position in her diurnal motion round the earth, this oval of water must shift with her; by which means are affected those two floods and ebbs, observable every 25 hours.

2. Since

2. Since in the conjunctions and oppositions of the sun and moon, the gravitation of the water to the sun conspires with its gravitation towards the moon; but in the quadratures, the water raised by the sun is depressed by the moon: hence it is that the *tides* are greater in the *syzyges* than in the quadratures.

That in effect there are two *tides* every natural day, from the action of the sun, as there are in the lunar day from that of the moon; all governed by the same laws: only those caused by the sun are much less than those caused by the moon; because though the sun be ten thousand times bigger than both the earth and moon, yet he is at so immense distance, that the earth's semi-diameter bears no proportion thereto.

Hence the different *tides* depending on the particular actions of the sun and moon, are not distinguished but confounded. The lunar tide is somewhat changed by the action of the sun; and this change varies every day, by reason of the inequality between the natural and lunar day.

3. Since the greatest *tides* about the equinoxes (*viz.* those happening in the syzyges) arise from the sun and moon being in the equinoctial, and those about the solstices from the sun an moon being in the tropicks; for this reason those greatest *tides* about the equinoxes are greater than those about the solstices; since the greater the circle is, wherein the waters move, the greater is their agitation. And if the moon stood still in the pole, the swelling would become immoveable above the pole, and the high water be fixed therein.

4. Since the *tides* are somewhat changed by the libration of the waters, which us'd to retain a motion impressed on them for some time; for this reason the highest *tides* are not precisely in the very conjunction and opposition of the moon, but two or three *tides* afterwards.

5. Since the sun is somewhat nearer the earth in winter than in summer; hence it is that the greatest equinoctial *tides* are observed to be a little before the vernal equinox, and a little after the autumnal one.

6. Since the greatest of the two tides happening in every diurnal revolution of the moon, is that wherein the moon is nearest the zenith or nadir: for this reason, while the sun is in the northern signs, the greater of the two diurnal *tides* in our climates, is that arising from the moon above the horizon; when the sun is in the southern signs, the greatest is that arising from the moon below the horizon.

7. Such would the *tides* regularly be, if the earth were covered with sea very deep; but by reason of the shoalness of some places, and the narrowness of the straights in others, by which the *tides* are propagated, there arises a great diversity in the effects not to be accountable for, without an exact knowledge of all the circumstances of the place; as the position of the land, and the breadth and depth of the channels, *&c.*

For a very slow and imperceptible motion, of the whole body of water, where it is (for example) two miles deep, will suffice to raise its surface 10 or 12 feet in a *tide*'s time; whereas if the same quantity of water were to be conveyed through a channel of 40 fathom deep, it would require a very great stream to effect it in so large inlets as are the channel of *England*, or the *German* ocean; whence the tide is found to set strongest in those places where the sea grows narrowest, the same quantity of water being in that case to pass through a smaller passage.

This is most evident in the *Straights* between *Portland* and cape *de la Hogue* in *Normandy*, where the *tide* runs like a sluice; and would be yet more between *Dover* and *Calais*, if the *tide* coming round the island did not check it.

And this force being once impressed between the water, continues to carry it above the level of the ordinary height in the ocean, particularly where the water meets a direct obstacle, as it does in St. *Malo*; and where it enters into a long channel, which running far into the land, grows very strait at its extremity, as it does at the *Severn* sea, at *Chepstow*, and *Bristol*.

This shoalness of the sea, and the intercurrent continents, are the reasons that in the open ocean, high-water is not at the time of the moon's appulse to the meridian, but always some hours after it, as it is observed upon all the western coast of *Europe* and *Africa*, from *Ireland* to the cape of *Good Hope*; in all which a south-west moon makes high-water, and the same is reported to hold in the west of *America*.

It would be endless to recount all the particular solutions, which are only corollaries from this doctrine; as why the lakes and seas, such as the *Caspian* sea, and the *Mediterranean* sea, the *Black* sea, and *Baltick*, have no sensible *tides*: for lakes having no communication with the ocean, can neither increase or diminish their water, whereby to rise and fall; and seas that communicate by such narrow inlets, and are of so immense an extent, cannot in a few hours time receive and empty water to raise or sink their surface any thing sensibly.

To demonstrate the excellency of this doctrine, the example of the *tides* in the port of *Tonquin* in *China*; which are so extraordinary, and different from all others we have yet heard of, may suffice. In this port there is but one flood and ebb in 24 hours, and twice in each month; *viz.* when the

moon

moon is near the equinoctial, there is no *tide* at all, but the water is ſtagnant; but with the moon's declination there begins a *tide*, which is greateſt when ſhe is in the tropical ſigns; only with this difference, that when the moon is to the northward of the equinoctial, it flows when ſhe is above the earth, and ebbs when ſhe is under, ſo as to make high-water at moon-ſetting, and low-water at moon-riſing: but on the contrary, the moon being to the ſouthward, makes high-water at riſing, and low-water at ſetting, it ebbing all the time ſhe is above the horizon.

The cauſe of this odd appearance is ſuggeſted by Sir *Iſaac Newton*, to ariſe from the concurrence of two *tides*, the one propagated in ſix hours out of the great *South Sea* along the coaſt of *China*, the other out of the *Indian Sea* from between the iſlands, in twelve hours, along the coaſt of *Malacca* and *Camboya*.—The one of theſe *tides* being produced in north latitude, is, as has been ſaid, greater, when the moon being to the north of the equator, is above the earth; and leſs, when ſhe is under the earth.—The other of them, which is propagated from the *Indian Sea*, being raiſed in ſouth latitude, is greater when the moon declining to the ſouth, is above the earth; and leſs, when ſhe is under the earth: ſo that of theſe *tides*, alternately greater and and leſſer, there come always ſucceſſively two of the greater, and two of the leſſer together every day, and the high-water falls always between the arrival of the two greater floods; and the moon coming to the equinoctial, and the alternate floods becoming equal, the *tide* ceaſes, and the water ſtagnates; but when ſhe has paſſed to the other ſide of the equator, thoſe floods which in the former order were the leaſt, now becoming the greater, that which before was the time of the high-water, now becomes the low-water, and the converſe: ſo that the whole appearance of theſe ſtrange *tides* are, without any forcing, naturally deduced from theſe principles, and is of great argument, ſay the *Newtonians*, for the certainty of the whole theory.

The next conſiderable phænomenon which happens in the terraqueous globe, is an *earthquake*.

Earthquake is a vehement ſhake or agitation of ſome conſiderable place, or part of the earth, from natural cauſes; attended with a huge noiſe like thunder, and frequently with an eruption of water, or fire, or ſmoak, or wind, *&c.*

Earthquakes are the greateſt and moſt formidable phænomena of nature.—*Ariſtotle* and *Pliny* diſtinguiſh two kinds, with reſpect to the manner of the ſhake, *viz.* a *tremor*, and a *pulſe*; the firſt being horizontal, in alternate vibrations, compared to the ſhaking of a perſon in an ague; the ſecond perpendicular, up and down: which latter kind are alſo called by *Ariſtotle* Βραστοι from the reſemblance of their motion to that of boiling.

Naturaliſts are divided on the cauſes of *earthquakes*. Some aſcribe *earthquakes* to water, others to fire, and others to air; and all of them with a great appearance of reaſon. To conceive which it is to be obſerved, that the earth every where abounds in huge ſubterraneous caverns, veins, and canals, particularly about the roots of mountains: that of theſe cavities, veins, *&c.* ſome are full of water, whence are compoſed gulphs, abyſſes, ſprings, rivulets; and others full of exhalations; and that ſome part of the earth are replete with nitre, ſulphur, bitumen, vitriol, *&c.*

This premiſed. Some are of opinion, 1. That the earth itſelf may be the cauſe of its own ſhaking; when the roots or baſis of ſome large maſs being diſſolved, or wore away by a fluid underneath, it ſinks into the ſame, and with its weight occaſions a *tremor* of the adjacent parts; produces a noiſe, and frequently an inundation of water.

2. That the ſubterraneous waters may occaſion *earthquakes*, by their overflowing, cutting out new courſes, *&c.* and that the waters being heated, and rarefied by the ſubterraneous fires, may emit fumes, blaſts, *&c.* which by their action, either on the water, or immediately on the earth itſelf may occaſion great ſucculſions.

3. That the air may be the cauſe of *earthquakes*; for air being a collection of fumes and vapours raiſed from the earth and water; if it be pent up in too narrow viſcera of the earth, the ſubterraneous, or its own native heat, rarefying, and expanding it, the force wherewith it endeavours to eſcape, may ſhake the earth: hence there ariſe divers ſpecies of *earthquakes*, according to the different poſition, quantity, *&c.* of the impriſoned air.

Laſtly, that fire is a principal cauſe of *earthquakes*; both as it produces the aforeſaid ſubterraneous aura, or vapour; and as this aura, or ſpirit, from the different matter or compoſition, whereof ariſe ſulphur, bitumen, and other inflammable matters, is kindled either from ſome other fire it meets withal, or from its colliſion againſt hard bodies, or its intermixture with other fluids; by which means burſting out into a greater compaſs, the place becomes too narrow for it; ſo that preſſing againſt it on all ſides, the adjoining parts are ſhaken; till having made itſelf a paſſage, it ſpends itſelf in a volcano, or burning mountain.

This laſt ſentiment is very near that of Dr. *Liſter*, who ſays, that the material cauſe of thunder, lightning, and *earthquakes*, is one and the ſame, *viz.* the inflammable breath of the pyrites, which is a ſubſtantial ſulphur, and takes fire of itſelf.

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The difference between these three terrible phænomena's he takes only to consist in this; that this sulphur in the former is fired in the air; and in the latter under ground: which is a notion that *Pliny* had long before him; *quid enim*, says he, *aliud est in terrâ tremor, quam in nube tonitru?*

MIDWIFRY.

MIDWIFRY, is the art of helping or assisting a woman in labour, so as to facilitate her delivery, without any danger to the woman or to her fruit.

To proceed with the same order on this important subject, as I have done on all others, I must begin by *pregnancy*, the *different sorts thereof*, and the *signs of a true*, or *false pregnancy*, &c. all that could be previous to it has been explained in my treatise of *Anatomy*.

PREGNANCY, properly taken, is a tumour of the belly, caused by the infant situated in the womb.

The symptoms of a *pregnancy* are, when in a few days after the conjugal act, a small pain is perceived about the navel, attended with some gentle commotions in the bottom of the abdomen, the suppression of the menses, or their flowing in less quantity than usual, vomiting, loathing, longing, &c. the breasts beginning to swell, grow hard and painful, and contain a little milk. The nipples also becoming larger, firmer, and darker coloured, a livid circle appearing round them, the eyes seeming sunk and hollow: but the most certain sign is, if by introducing the finger in the *vagina*, the inward orifice of the matrice is found exactly shut, without any hardness, and in a good situation, as likewise a considerable distension of the body of the matrice.

The embrio is perceived to move about the fourth month, sometimes sooner, sometimes later, according to its strength; for some women feel it as soon as the second month, or even sooner; and others about the third month only, or later.

Women who have a *false conception*, have their belly equally distended on all sides; and those big of a *true conception* have theirs prominent in the middle, and the navel much more raised: therefore in the doubt of a *pregnancy* of four or five months or more, if the navel of the woman is found sunk, and the orifice of her womb small and hard, it is almost an infallible sign that she is not big of a natural conception.

These false *pregnancies* happen commonly to women who are not regular as they should be, in the evacuation of their menses, either for quantity or quality, and for the time they must flow; but particularly from 35 to 40 years of age; because that evacuation begins at that age, not to be so regular as before: therefore in those suspicions of *pregnancy*, one must above all things inform himself of the manner women used to have their menses, as well as of all other dispositions which preceded and accompanied the swelling of the belly, but particularly of the disposition of the navel, and of the internal orifice of the matrice.

The just, and more certain judgment that can be formed of *pregnancy*, proceeds from the inward orifice of the matrice, which the nearer her term a woman is, grows thinner, shorter, and more flattened.

Thus it is very easy to gratify the curiosity of a woman, who desires to know if she be with child or not; but it is absolutely impossible to discover if it be with a boy or a girl.

We must next instruct the pregnant woman, *in what manner she is to govern herself during the whole course of gestation, when accompanied with no considerable accidents, and how to avoid those she is exposed to.*

I'll confine myself, in this place, to caution them against the most dangerous accidents they are exposed to; beginning by a concise and general regimen.

That regimen consists principally in refraining as much as possible, the depraved appetite they are troubled with during the time of gestation; which they may do by avoiding with care, all they are conscious could occasion or indulge those depraved appetites, vulgarly called *longings*; and consulting, in those occasions, their reason, the health and preservation of their fruit, rather than their depraved imagination, or their sensuality.

It would be very proper, that a woman should abstain from *coition*, for several days after she has conceived, for the great emotions, during the amorous embraces, may be a great obstacle to the formation of the fœtus; according to this advice of *Hippocrates*, *lib. de sterilibus*, *Si mulier*, says he, *se concepisse cognoverit, primo tempore non amplius ad virum accedat, sed quiescat.*

A woman with child must also avoid, if possible, all sorts of violent exercises, particularly dancing, jumping, riding, &c. because those violent exercises cause often an abortion, by relaxing the ligaments

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of the matrice. Though a moderate exerciſe, contributes more to a ſafe and quick delivery, than all the means art can ſupply us with. A moderate exerciſe, beſides, renders the preparation and coction of the aliments the fœtus is fed with in the womb, more laudable, and free from that great quantity of terreſtrial and phlegmatick particles, a bad digeſtion, occaſioned by the inaction of the mother, would leave them loaded with; whereby the fœtus itſelf would become heavy, lumpiſh, and almoſt uncapable of moving in the womb; and at laſt fix on one ſide rather than the other, to which laſt accident the little quantity of the water it floats in contributes.

So ſoon as a woman knows herſelf with child, ſhe is not to lace herſelf too cloſe, for while ſhe expects to ſave her fine ſhape, ſhe prejudices her child, by confining him within thoſe ſtays, and thereby either hindering him from growing, or forcing him to come before his time, or rendering him counterfeit; and miſſing beſides her chief end; for thoſe women, who thus endeavour to appear of a fine ſhape, though they be big with child, ſpoil their belly, which after their delivery, remains hanging as a bag; for the belly, by being thus confined, finding no room to dilate itſelf equally on all ſides, is forced to dilate only towards the bottom, which bears all the burden.

Women with child being often ſubject to be hard bound, becauſe the matrice, by its weight preſſing hard on the inteſtine *rectum*, is an obſtruction to the natural evacuation of the excrements, thoſe afflicted with that incommodity, muſt abſtain from all ſorts of aliments which could contribute towards it, by increaſing the heat of the entrails, a pregnancy is but too often accompanied with it; but above all, from the immoderate uſe of ſpirituous liquors. The frequent uſe of roaſted apples, of boiled prunes, of figs, and of all that can open the body, proves very beneficial to women who find themſelves extremely conſtipated, during geſtation; and if theſe things are not ſufficient, glyſters muſt be adminiſtered to them; of a decoction of marſh-mallows, parietary and annis-ſeeds, in which muſt be diſſolved two ounces of brown coarſe ſugar, adding to it a ſpoonful of ſweet oil; avoiding above all things thoſe irritating glyſters which would excite a looſeneſs, or a too great evacuation, which would cauſe an abortion or miſcarriage.

A pregnant woman ſhould never be frightned nor ſurprized by any bad news, capable to excite within her an exceſſive uneaſineſs, or ſorrow; for thoſe paſſions, when violent, are capable to throw the whole Oeconomy of the generation into a diſorder or confuſion, and even make a woman miſcarry at that very inſtant.

Vomiting and the ſuppreſſion of the menſes, are often the firſt ſigns whereby women perceive that they are with child. That vomiting is not always excited, as it has been falſly imagined, by the humours gathered in the ſtomach by the ſuppreſſion of the menſes, eſpecially in the firſt days of their pregnancy; but it is occaſioned by the ſympathy which is between the ſtomach and the matrice, by reaſon of the ſimilitude of their ſubſtance, and that the nerves inſerted in the ſuperior orifice of the ſtomach, have communication by the ſame continuity, with thoſe which run to the matrice, which are portions of the ſixth pair of thoſe of the brain; ſo that the matrice, which by reaſon of its membranous compoſition, has a very exquiſite ſenſe, happening to dilate itſelf in the pregnancy, is then ſuſceptible of ſome pain, which being communicated at the ſame time by means of the continuity of the nerves, to the ſuperior orifice of the ſtomach, cauſes thoſe vomitings and nauſea's which commonly happen, eſpecially in the firſt month of geſtation.

In the firſt month of geſtation, *vomiting* is but a ſimple ſymptom, not at all dangerous; but if it continues longer, it extremely debilitates the ſtomach, renders the digeſtion of the aliments imperfect, which generates a great quantity of humours in the viſcera, which muſt be purged. Add to this, that the continual ſubverſions of the ſtomach, cauſing a great agitation and compreſſion of the belly of the mother, would procure an abortion.

The remedies preſcribed by ſome Phyſicians, to ſtop theſe vomitings when they laſt too long, and are too violent, are all ſorts of gentle catharticks, which purge gently downwards, as manna, rhubarb, tamarind, caſſia, ſyrup of violets, of chichory, *&c.* For my part, though I approve this practice, I would preſcribe previouſly to it ſome drops of laudanum, to appeaſe the convulſive motions of the ſtomach, and then preſcribe the catharticks, to evacuate the humours which debilitate the digeſtive faculty of its diſſolvent.

The pains cauſed by the *extenſion*, *dilatation*, or even *laceration* of the ligaments of the matrice, are often remedied by the woman keeping her bed for ſome days, by bleeding, and by ſome fomentations on the part, made with emollient herbs, boiled in lees of wine. If thoſe pains, eſpecially thoſe in the *loins*, are accompanied with ſome excretions of the matrice, which had not appeared before, and thoſe excretions are tinged with blood, it is certain that the matrice begins to open, and there will be a miſcarriage. If by ſome violent ſhake or fall the ligaments of the matrice be broken, and the woman cannot be perſuaded to keep her bed, her belly muſt

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be ſupported by a bandage made for the purpoſe, and wait as patiently as ſhe can for the time of her delivery.

As to the pains in the breaſts. So ſoon as a woman has conceived, her monthly evacuations being ſtopped, though ſhe continues to make daily new blood, it is neceſſary, that as there is none conſumed during the firſt month of geſtation, the veſſels which are too full, ſhould overflow thoſe parts which are the moſt diſpoſed to receive it: as are the glands and glandulous bodies, particularly the breaſts, which receive abundance of it, which filling and ſwelling them extremely, cauſes thoſe pains which women with child feel in them, to which thoſe who have only a ſuppreſſion of their menſes are ſubject likewiſe.

In thoſe beginnings a woman muſt only take care not to hurt thoſe parts by lacing her ſtays too cloſe, to avoid contuſions, which would perhaps degenerate into inflammations, and thoſe inflammations into abſceſſes: but when after the third month of geſtation, the blood flows thither in too great abundance, it muſt be evacuated by bleeding in the arm, which is the ſureſt remedy on thoſe occaſions.

The moſt dangerous ſymptoms a woman with child is ſubject to, are a *cough*, and a *difficulty of reſpiration*, eſpecially if the cough be very violent, which often cauſes a miſcarriage.

Whatever may be the cauſe of the *cough* of a woman with child, ſhe muſt abſtain from all the aliments which could increaſe it, ſuch as ſalt, pepper, and all ſorts of acids; uſing thoſe which can help towards ſweetning the maſs of the blood. I would preſcribe to her every other night, when ſhe goes to bed, a large glaſs of emulſion, made with the four large cold-ſeeds, and the ſyrup of maiden-hair, and a dyet drink made with jujubes, dates, and liquorice.

If the difficulty of reſpiration and cough proceeds from the matrice preſſing too hard on the diaphragm, there is no better remedy than a moderate exerciſe. All other remedies preſcribed on that occaſion are needleſs.

As to the *various ſwellings and pains in the thighs and legs*, ſome begin the cure of this diſtemper by bleeding the arm, which cannot be diſapproved, provided it does not exceed three ounces.

The ſame ſuperfluous blood, ſtopped by the ſuppreſſion of the menſes, which cauſes the various ſwelling of the thighs and legs, cauſes likewiſe the *hæmorrhoides* or *piles*, almoſt all breeding women are afflicted with.

If they be ſmall and without pain, whether internal or external, it ſuffices to hinder them from growing bigger; which may be done by remedies proper to diſſipate the fluxion, but the cure of thoſe extremely ſwelled, muſt be began by appeaſing the pain; which is done by *bleeding* the woman once or twice in the arm, and ordering her to abſtain from coition, or any thing elſe which can contribute towards over-heating her. But if the excrements ſtopped in the rectum, be the cauſe of the *hæmorrhoides*, they muſt be evacuated by a glyſter made only with a decoction of bran, and ſome leaves of marſh-mallows, adding to it a ſpoonful of honey, and another of oil of ſweet almonds; lining the canule or clyſter-pipe with the gut of a chicken, for fear it ſhould hurt the anus. The *piles*, if they be external, muſt alſo be anointed with an ointment made of *populeum*, and an oyſter-ſhell calcined, very well pounded, and mixed afterwards with the *populeum*.

If the tumour be not diſſipated by the aforeſaid remedies, *leeches* muſt be applied to the anus, which by their ſucking will empty the blood ſtopped in thoſe parts.

It happens alſo, that a woman with child is often afflicted with an *immoderate flux of the belly*, or *looſeneſs*.

There are three different ſorts of theſe *fluxes*, the firſt called *lienterick*, in which the aliments are evacuated with very little appearance of digeſtion, proceeding from the imbecillity of the ſtomach: the ſecond *diarrhœick*, when the excrements are evacuated without any conſiderable pain in the inteſtines: and the third, which is the moſt dangerous, is the *dyſenterick*, whereby the patient voids blood together with the humours and excrements, with violent pains cauſed by the ulceration of the inteſtines.

Of what ſort ſoever be the flux of the belly, if it be immoderate, and continues long, it always puts the woman with child in great danger of abortion. If it be a *lienterick flux*, cauſed by the immoderate and extravagant appetite of the pregnant woman; that appetite muſt be reſtrained above all things; in lieu thereof ſhe muſt make uſe of good aliments of an eaſy digeſtion, and in a ſmall quantity at once, till the ſtomach has recovered its former ſtrength.

When the flux is *diarrhœick*, and nothing elſe is evacuated but the excrements contained in the inteſtines, there is not the leaſt danger, provided it be not attended with pains, and does not continue long, when one muſt content himſelf then with moderating that flux without ſtopping it. But if it laſts longer than four or five days, it muſt be ſtopped by degrees, in purging, by means of gentle cathartick, the acrimonious humours, which are the cauſe thereof.

But if notwithſtanding the aforeſaid regimen

and remedies, the flux continues, and is changed into a *dyſenteria*, the ſtools of the patient being very frequent, painful, and bloody, then ſhe is in great danger of miſcarrying; which muſt be avoided if poſſible, by preſcribing to her, beſides the remedy above mentioned, ſome drops of laudanum, and clyſters made with a decoction of the leaves and roots of plantain, of red roſes, and pomegranate-peel, boil'd in the water of a forge, to which may be added two drachms of ſanguis draconis, or an infuſion of rhubarb in good old red wine, the extract of mars aſtringent, and a julep made of plantain water, and ſyrup of quinces, an ounce of each, and fifteen drops of laudanum. But the purgatives muſt be uſed before the aſtringents, ſince they are preſcribed to carry off the cauſe of the diſtemper, which otherwiſe would return, even with more violence than before, if we minded nothing elſe but how to appeaſe its ſymptoms.

If the flux ſhould continue, a revulſion muſt be made, by bleeding in the arm, if the ſtrength of the woman will allow it; preſcribing afterwards ſome pleaſant ſtyptick.

There is a great difference betwixt the flux above mention'd, and what is called *a loſs of blood*, or *flooding*; for in this the blood flows from the bottom of the matrice, with pain in abundance, and without interruption, unleſs ſome clods of congealed blood, ſeem ſometimes to diminiſh the accident, by ſtopping, for a ſhort time, the place whence it flows; but ſoon afterwards, thoſe clods of blood being expelled, or falling of themſelves into the matrice, it begins to flow anew, with ſtill greater violence than before; which ſoon cauſes the death both of the mother and child, unleſs it be remedied, by the quick delivery of the woman; or if ſhe be not far gone in her pregnancy, by the expulſion of the embrio, which I know by experience gives immediate relief; and for which I have preſcribed with great ſucceſs, *a few drops of oil of guaiacum*.

As to *the weight, and bearing down, or relaxation of the matrice in women with child*. Whatever may be the cauſe of the *bearing down of the matrice*, the beſt remedy is for the woman to keep her bed; for while ſhe is up, the weight of the part increaſes the relaxation of the ligaments; and if her circumſtances will not allow it, ſhe muſt wear a peſſary, to keep the part in its natural ſituation: and if her belly be very high, it muſt be ſupported by a large bandage made for that purpoſe.

As to the *hydropſy of the matrice*, it is nothing elſe but a quantity of water gathered in the capacity of the matrice. This accident has often deceived Phyſicians, Surgeons, Midwives, and the patients themſelves, who expecting to be delivered of a child, void only abundance of water.

The beſt remedy for thoſe ſorts of hydropſies, if there be a child with it, is to wait with patience the hour of the delivery, uſing at the ſame time deſiccative remedies. If there be nothing but water contained in the matrice, the half-bath is very proper to make it open, as are likewiſe all the remedies which provoke the menſes, and if thoſe remedies have no effect, the woman muſt be preſcribed the uſe of mineral waters.

As to the *œdematous ſwelling of the labia of the pudendum*. The matrice is often ſo full of humidities, that they overflow on the outward parts, eſpecially on the *labia* of the *pudendum*.

This ſwelling of the labia of the matrice is lucid and almoſt tranſparent, much like an hydrocelle; it muſt be remedied by opening the ways of the urine, with ſome diureticks.

I'll conclude this conciſe account of the maladies a woman with child is ſubject to, *by the abortion, and cauſes thereof*. When the child is already formed, and has began to have life, let it be ever ſo little, if it happens to come out before the time appointed by nature, it is an *abortion*; which can happen from the end of the ſecond month, or even before, to that of the ſeventh only; for after that time, it is always a true labour; becauſe the child being then ſtrong enough, and having a ſufficient perfection, can live, which it cannot before that time.

All ſorts of violent maladies, can be the cauſe of *abortion*, becauſe they kill the child, who being dead cannot remain long in the matrice; which alſo puts the mother in danger of her life, who often periſhes ſoon after her miſcarriage, or even before. Even intermittent fevers alone, can cauſe an *abortion*, by exciting falſe pains in the womb, which occaſion a real labour. A violent and frequent vomiting, and the pains in the loins, and the violent cholicks, can cauſe the ſame accident. Likewiſe the ſtrangury, becauſe there happens then continually, very ſtrong compreſſions of the abdomen, for the evacuation of the urine.—A violent cough by its frequent agitation, puſhing ſuddenly and with great efforts the diaphragm downwards, gives, likewiſe, violent ſhakes to the matrice.—A violent looſeneſs puts a woman with child in danger of miſcarrying; and much ſooner, if afterwards there happens a teneſma, *i. e.* frequent and violent motions to go to ſtool.

If the menſes flow much during geſtation, it is impoſſible the child ſhould be ſtrong, ſince in that evacuation,

evacuation, there happens a very great diſſipation of the ſpirits of the mother; and the matrice being too much humected, relaxes and opens eaſily.

But one of the moſt dangerous accidents, which cauſe an *abortion* or miſcarriage, is the ſeparation of the after-birth from the matrice.—The hydropſy of the matrice hinders the child from being brought to perfection.

All that agitates, and ſhakes violently the body of a woman with child, is capable to cauſe a miſcarriage; as a violent work, a ſtrong contuſion, or motion, either in falling, jumping, dancing, running a foot, or on horſeback, riding in a coach, or in a cart, hollowing, laughing immoderately, or ſome blow received on the belly. — A ſudden and unexpected violent noiſe, like that of thunder, cannon, &c. can alſo cauſe an abortion, if it be attended with fear, eſpecially in young women. — Fœtid and ſtinking ſmells, can alſo contribute to a miſcarriage, and particularly that of charcoal.

There are alſo indiſpoſitions of the matrice, which produce the ſame accident; as when it is callous or ſo ſmall, or ſo much compreſſed by the epiplon, that it cannot extend itſelf ſo much as it is neceſſary to lodge the child at eaſe, with the after-birth, and the water it ſwims in. —This can happen, likewiſe, if the woman, to appear a fine ſhape, laces herſelf too cloſe, or makes uſe of a buſk.—The frequent uſe of coition, eſpecially towards the latter months of geſtation, can produce the ſame accident; becauſe the matrice then being extremely full, inclines much downwards, and its internal orifice being very near, is puſhed upwards by the penis, which thereby excites it ſometimes to open ſooner than it ſhould.

There are likewiſe, cauſes of abortion, which proceed from the children themſelves, as when they are monſtrous; when they have not a natural ſituation; which diſturb them ſo much, that they force the matrice to expel them; and likewiſe when they are ſo big that it cannot contain them till term, nor the mother ſupply them with a ſufficient quantity of aliments.

As to *the ſigns of an approaching miſcarriage*. —If one perceives, that after one, or ſeveral of the accidents above ſpecified, a woman has a great pain in her belly, and about her loins, and with it, ſome clods of blood are voided through the matrice, and the membranes of the child are broken, *they are ſure ſigns* of an approaching miſcarriage, which in that caſe cannot be prevented by any remedy whatever. If a woman feels a great weight in her belly, which falls as a lump on that ſide the child lies, and her matrice voids ſtinking and cadaverous humidities, it is a ſign that ſhe is to miſcarry ſoon of a dead child.

It is certain, that a woman who miſcarries, is in a much greater danger of her life, than one who goes her full time; becauſe, *abortion* is entirely againſt nature, and is very often accompanied with a great loſs of blood, which is more or leſs dangerous, according as the cauſe of abortion is more or leſs violent, whether it has been occaſioned by remedies taken inwardly, or by ſome blow, fall, *&c.*

The beſt and moſt ſpecifick remedies for all the external accidents, which can cauſe an abortion, is the repos; which muſt be proportioned to the violence of the accident. If a woman is to be let blood, after a violent fall, blow, *&c.* to prevent a miſcarriage, it ſhould be done as ſoon as poſſible.

From this *theoretical* part of *Midwifry*, I'll paſs to the *practical* part thereof; where I'll treat of a *natural labour*, and of thoſe which are *againſt nature*, teaching the manner of helping a woman in the former, and how to remedy all the others; beginning by informing the reader what we underſtand by *delivery, the differences, and different terms thereof.*

We underſtand by delivery the emiſſion, or extraction of a child at term, out of the matrice; which definition includes both the *natural labour*, and thoſe *againſt nature*.

A *natural labour*, muſt be *at term*; it muſt be quick, and without any conſiderable accident; the child muſt be *alive, well form'd*, preſenting himſelf in a *natural ſituation*; for if there be any of thoſe four conditions wanting, the labour is againſt nature: and much more ſo, if ſeveral of them are wanted.

The *ſigns which precede a natural labour*, and which happen a few days before, are, that the woman begins to feel ſome uncommon pains in her loins, and the tumour of her belly which was very high, falls down all on a ſudden, which hinders her from walking ſo eaſily as ſhe uſed to do, and cauſes her frequent motions of making water; there flows then from the matrice certain ſlimy humidities, deſigned by nature to humect the paſſage, and render it ſlippery, that the inward orifice thereof may be eaſily dilated when wanted.

The *ſigns which accompany a preſent labour*, i. e. indicate that a woman is really in *labour*, are that ſhe feels great pains towards the region of the reins and loins, which coming and growing ſtronger by intervals, are felt in the bottom of her belly. All her privy parts are tumefied, becauſe the head of the child when near the paſſage, puſhes forward the neighbouring parts, which appear tumefied likewiſe; and when a vomiting happens, it is commonly a ſign that the woman ſhall be ſoon

delivered, becauſe thereby the pains grow more frequently greater and longer; ſhort and ſmall pains, though frequent, rendering moſt commonly a labour very tedious, and exhauſting the ſtrength of a woman. When the humidities, voided at that time through the matrice, are tinged with blood, it is an infallible mark that the woman will ſoon be delivered; and then if the finger be introduced into the neck of the matrice, its inward orifice will be found open, and the mouth thereof; the membranes in which the child is contained, preſent themſelves, which membranes are ſtrongly compreſſed, at every pain the woman feels, during which they are felt to reſiſt, and appear to the finger more or leſs hard, as the pains are more or leſs ſtrong. Afterwards the pains growing continually ſtronger and ſtronger, the membranes break by the ſtrong impulſion of the waters, which are evacuated in an inſtant; and then the child is eaſily felt, ſince it preſents itſelf at the aperture of the inward orifice of the matrice.

When all thoſe ſigns, or part of them, meet together, whether the woman be at term or not, one may be ſure that ſhe'll ſoon be delivered. She muſt not be put in labour, before the neceſſity thereof be known by thoſe ſigns; otherwiſe it would be tormenting the mother and her child in vain, and put them both in danger of their lives; for though the inward orifice of the matrice, be ſometimes enough dilated, for the introduction of the finger into it, and the head of the child is even felt through the membranes, and the woman feels ſome pains in the abdomen, one muſt not always conclude hence, that ſhe is then really in labour; for though there be a great appearance of it, the thing notwithſtanding is not entirely ſure, unleſs thoſe pains be felt at the bottom of the belly, and the waters to range themſelves between the head of the child and the membranes: therefore that circumſtance muſt be carefully obſerved, to avoid miſtakes in the prognoſtick.

As to the membranes of the fœtus, are the parts which are formed firſt, after the conception, in order to preſerve the ſeed of the man, and hinder the diſſipation of the ſpirits it is impregnated with, whereby the intention of nature would be fruſtrated; they are likewiſe thoſe, which together with the waters, preſent themſelves firſt at the paſſage in the time of the delivery.

The waters gather'd in the membranes, ſerve to facilitate the motion of the child, by its ſwimming in them, and leſt by his frequent motions he ſhould wound the matrice, in ſtriking againſt it, which would ſometimes cauſe abortion. They defend him, beſides, againſt external injuries, in eluding the violence of the blows which the woman could receive on her belly; and contribute much towards rendering the extraction of the child eaſy in the delivery, becauſe they render the paſſage very ſlippery; and humecting the orifice of the matrice, makes it to dilate itſelf much better, when they come to flow, when the child is ready to come into the world, or a little before: for otherwiſe the delivery would be attended with more difficulties, and the mother more tormented.

I'll paſs to the parts, by means whereof the child receives its food in the matrice; which parts are the *placenta*, and the *umbilical veſſels*.

The PLACENTA is a fleſhy and ſpongeous maſs, ſemblable, in ſome meaſure, to the ſubſtance of the melt, for the greateſt part is compoſed of an infinity of veins, arteries, and lacteal veſſels.

The *placenta*, is formed of an accumulation of the menſtrual blood of the matrice.

When there are two children in the matrice, and even where there are three, if they be true twins, *i. e.* generated of one and the ſame coition, they have commonly but the ſame *placenta* with only as many ſtrings terminated to it, as there are children; which notwithſtanding are entirely ſeparated from one another by their particular membranes, in which each child is contain'd with his waters a-part; unleſs they have their bodies adherent to one another; in which caſe, twins of that nature, who, therefore are monſtrous, have likewiſe the ſame waters, and the ſame common membranes. But if there be a *ſuperfetation*, there will be as many *placenta's* as there are children. But tho' a ſingle after-birth be oftener common to ſeveral children, it has been obſerv'd, that the veſſels of the navel-ſtring of each child, both the veins and arteries, diſtributed or ramified throughout the whole ſubſtance of that common after-birth, are always entirely ſeparated from one another; ſo that the veſſels, which ſerve to feed one child, have no communication by *anaſtomocis*, nor otherwiſe, with thoſe deſtined to feed the other children. Which is the cauſe that each child having his principle of food and life, ſeparately from one another, and being lodg'd in different membranes and waters, one of thoſe children, can ſometimes be dead in the womb, while the other remains alive; provided the dead child does not remain long enough in the matrice to be corrupted.

From the middle of the after-birth ariſes a ſtring, compoſed of ſeveral veſſels join'd together. Some authors reckon four of thoſe veſſels, *viz.* two veins, and two arteries; and others five, adding the ouraque to it: but it is very certain, that there are but three veſſels to the human fœtus, *viz.* a vein, and two arteries.

Thoſe

Thoſe three veſſels which compoſe the ſtring are enveloped with a pretty ſtrong and thick membrane.

All children, whether males or females, are commonly ſituated in the middle of the matrice. Their poſtures and figures, are different according to the times of the pregnancy. For in the firſt months, the embrio is always found of a round figure, a little oblique, having its back-bone moderately bowed inward, the thighs folded, and a little rais'd, to which the legs are joined; ſo that the heels approach the buttocks, and the extremities of the feet are turned inwards; its arms are bowed, and its hands near the knees, towards which its head inclines, leaning forwards in ſuch a manner, that its chin touches the breaſt. The embrio has then its backbone turn'd towards that of its mother, its head upwards, its face forwards, and its feet downwards, and in proportion as it grows, extends its members, which it had exactly folded during the firſt months.

We muſt not imagine, notwithſtanding, that the child is always preciſely in the poſture above deſcribed, ſince it changes ſometimes that of its arms and legs, in bending or extending them more or leſs, throwing them from one ſide to the other, according as it is excited to it, by ſeveral different cauſes, as women with child can witneſs, who feel it move its parts in a different manner, after which it generally re aſſumes its former ſituation above deſcribed.

The child keeps commonly that firſt ſituation, till the ſeventh or eighth month, when its head being grown very big, it tumbles downwards by its own weight, againſt the inward orifice of the matrice, its feet being then upwards, and its face turn'd towards the buttocks of the mother; and when it is turned contrariwiſe, that is not not natural; for beſides that, the face of the child coming outward, would be much bruiſed by the bones of the woman; the labour-pains could not puſh the child ſo eaſily out of the matrice, as they do when it has its body and face downwards; in which caſe the matrice, as well as the muſcles of the abdomen of the mother, contracting themſelves at the time of the pains, on the back of the child, who reſiſts the pain by that ſituation, its head is much eaſier forced through the paſſage.

When a woman with child is happily gone her full time, and falls in labour, ſhe muſt be ſuccoured in the following manner.

When by the ſigns heretofore mentioned, which precede and accompany the labour, one is convinced, that a woman is ready to lay in. The midwife is to begin by making the patient walk in her apartment, if her ſtrength permits, giving her from time to time, eſpecially immediately after ſhe has took a pain, two or three ſpoonfuls of white wine, burnt with cinnamon, but never any ſpirituous liquor, unleſs it be when the labour is tedious, two ſpoonfuls of cinnamon-water, though I would prefer to it a drachm of confection alkermes; recommending her, above all things, to reap all the fruit ſhe can of her pains, by ſtopping her breath, and forcing ſtrongly downwards, while ſhe feels them.

The midwife muſt feel from time to time the inward orifice of the matrice, to diſcover if the waters are ready to break, and if the delivery will ſoon follow; keeping all the while near the patient, to obſerve narrowly her motions, and complaints, for thereby one may judge well enough if the work goes forward, without being obliged to feel the woman often downwards.

There are ſome women, the inward orifice of whoſe matrice cannot be felt at the beginning of their labour. Becauſe they have that orifice ſituated very high towards the *rectum*. Notwithſtanding which, if the child be well turn'd, and the woman be really in labour, the head of the child is felt, through the ſubſtance of the matrice, to come down by degrees, and to reſiſt ſtrongly enough, to feeling, when the woman takes her pains.

The patient may lie down by intervals, to recruit her exhauſted ſpirits; but ſhe muſt take care not to lie long; though when a woman begins to be in labour, and her pains are ſmall and tedious, without any preparation of the water, ſhe muſt not be fatigued by making her ſet up too long. It is much better to make thoſe ſort of women lie down, and keep them very warm in their bed, to ripen their labour, till the waters begin to form themſelves, as it ſhould be; after which ſhe may get up, if the midwife judge proper, to increaſe, by that ſituation, the ſtrong pains, which come at that time.

When the waters of the child are well prepared and formed, the midwife muſt let them break of themſelves, without attempting to do it; for under pretence of forwarding her work by thus lacerating the membranes, ſhe on the contrary retards it, by that accelerated evacuation of the waters, which muſt ſerve to make the child ſlide with more facility, and leaves it dry; which afterwards hinders the pains from forcing it out ſo eaſily, as they would have done.

When the waters are broken of themſelves, the midwife will eaſily touch the child by the part which preſents itſelf firſt, and be ſure if it comes naturally, *i. e.* the head foremoſt, which ſhe'll feel hard, big, round, and even; but if it be another part, ſhe'll feel ſomething uneven, and hard, or ſoft, more or leſs, according to the part, which preſents itſelf. Imme-

Immediately after ſhe muſt make haſte to put the woman to bed, if ſhe is not there already, to help her in her delivery, which commonly happens ſoon after, if it be natural. But if ſhe finds that the child preſents itſelf in a ſituation quite different from the natural, and knows herſelf not capable to perform the operation, ſo as to ſave the mother and the child, ſhe is obliged in conſcience to ſend as ſoon as poſſible for a man-midwife, without waiting to the laſt extremity.

The woman in labour being placed in a proper poſture, and the waters broken, the man-midwife or midwife, ſhall introduce a finger into the inward orifice of the matrice, to know if it be the head of the child, which preſents itſelf; then having anointed his hand with pomatum or freſh butter, or otherwiſe he'll put, at the time of the pains, the ends of his fingers into the orifice of the matrice to dilate it, in parting them from one another. When the head of the child ſhall begin to appear, the midwife muſt puſh up the ſides of the matrice towards the back part of the head of the child, who when advanced forward as far as to the ears, muſt be taken with both hands on the two ſides, and, at the firſt great pain, draw, not in a direct line, but wavering, and his face downwards; obſerving carefully, that the naval-ſtring may not be turned round the child, for it would be broke, and one would pull too hard on the matrice. When the ſhoulders ſhall appear, the midwife muſt ſlide her fingers under the arms, and draw the child, who muſt be put on its ſide, its face towards her, leſt the blood and waters, which flow immediately, ſhould ſuffocate it, by falling into its mouth and noſe.

The next thing a man-midwife or midwife muſt do, is to ſee if there be no other child left in the matrice, for it happens often, that there are two, and ſometimes more; which is eaſily diſcovered by that the labour's pains continue after the birth of the child, and the woman's belly is ſtill extremely big; but to be better convinced of it, if ſhe introduces her hand into the entrance of the matrice, ſhe'll feel other waters in other membranes, with a child preſenting itſelf at the paſſage.

In that caſe the woman muſt not be delivered of the after-birth till after ſhe has been delivered of her other children, becauſe twins having moſt commonly but the ſame placenta for all, though there be ſeveral navel-ſtrings with as many ſeparations of the membranes, if it was extracted after the birth of the firſt child, the other children would be in ſome danger of their lives, becauſe that part is abſolutely neceſſary to them while they are in the matrice; and that extraction would cauſe a great loſs of blood to the mother. Therefore the navel-ſtring of the firſt child muſt be cut off, after it has been tied with a ſtrong thread four times double, faſtning the end thereof to the thigh of the woman, not for fear it ſhould re-enter the matrice, but to hinder it from diſcommoding the woman, in hanging between her legs, making likewiſe another ligature at its extremity, to hinder the evacuation of the blood: after which, having given that firſt born child to another perſon, the midwife ſhall make no difficulty to break immediately the membrances of the other child, for the evacuation of the waters (in caſe they are not broken of themſelves) becauſe the firſt having made the paſſage, the birth of the ſecond is thereby accelerated, of whom ſhe muſt be delivered, obſerving all the ſame circumſtances, preſcribed for the firſt; which done, ſhe muſt be delivered of the after-birth.

A woman muſt be delivered of the after-birth, as ſoon as the child is out of the matrice, and even before the naval-ſtring is tied and cut; for fear the matrice, which as ſoon as delivered of its burden, contracts itſelf as faſt as poſſible to re-aſſume its natural ſituation, ſhould cloſe itſelf, and thereby hinders (as it happens but too often) the extraction of the after-birth, which corrupting ſoon in the matrice, if it be left in it, either entire, or in part, cauſes very dangerous ſymptoms to the mother, and ſometimes her death.

To deliver the woman of the after-birth, the midwife muſt make two turns round her left-hand with the navel-ſtring, or with the ſame hand lay hold of it with a dry cloth, leſt it ſhould ſlip between her fingers, and with the right take it only, above the left, near the pudendum, drawing likewiſe very ſoftly with that hand, and leaning the ends of two fingers joined together, or only that of the index of the ſame right hand, extended and carried to the entrance of the vagina, on that navel-ſtring, according to its length; obſerving always to draw, and lean particularly towards the ſide where the after-birth is leſs adherent, and not to take the navel-ſtring covered over with the membranes of the child.

To facilitate the expulſion of the after-birth, the woman muſt blow hard into one of her hands ſhut, as ſhe would do into a bottle, to diſcover if it be flawed, or blow her noſe hard, or thurſt a finger into her mouth, as if ſhe would excite herſelf to vomit; or ſtopping her breath, force downwards, as if ſhe would go to ſtool; ſince all theſe different motions and agitations produce the ſame effect.

If notwithſtanding all theſe efforts, the woman cannot be delivered of the after-birth, the nurſe or ſome other ſkilful woman, muſt paſs ſoftly her hand over the belly of the patient, drawing it downwards in manner of friction, and if all this will not do, the hand muſt be introduced at laſt into the matrice, to extract it. There are ſometimes likewiſe

likewiſe, after-births ſo monſtrouſly big, that it is impoſſible to extract them, though the navel-ſtring holds faſt to them.

In thoſe caſes the man-midwife having well anointed his hand with oil or pomatum, and pared his nails, muſt introduce it into the matrice, to ſeparate the after-birth from it as gently as poſſible, and draw it out together with the clods of blood, which might be along with it. When the navel-ſtring is not broken, it ſerves to guide the hand to the place where the after-birth is ſituated; but when it is broke, the operator muſt take a particular care not to miſtake one part for the other, and draw the matrice; which will be eaſily avoided, if one has learned, that having introduced his hand into the matrice, he'll ſoon diſcover the difference between it and the after-birth, in that the after-birth is full of little inequalities, produced by the roots of the umbilical veſſels on that ſide they terminate in it; beſides, the veſſels ramified throughout its whole ſubſtance are eaſily felt, which ſubſtance is much more ſoft than that of the matrice.

But if notwithſtanding all theſe endeavours, the after-birth cannot be extracted, and if the matrice, becauſe of its inflammation, cannot be dilated enough to go and fetch it without an extreme violence, or if it be ſo adherent that it cannot be ſeparated from it; then to avoid a greater evil, moſt phyſicians and men-midwives are of opinion, that the operation ſhould be left to nature, helping it by means of remedies which can bring the after-birth to ſuppuration.

The remedies uſed in thoſe caſes are injections into the matrice made with a decoction of mallows, marſh-mallows, parietary, and lin-ſeed, to which muſt be added oil of ſweet almonds, or of white lilies; adminiſtring beſides to the patient pretty ſtrong glyſters, that the efforts ſhe'll make to go to ſtool, may accelerate the evacuation of the after-birth, by which means ſeveral evacuate it with the ſtools, without being ſenſible of it.

At the ſame time to avoid a fever or any other dangerous accidents, ſhe may be let blood in the arm or in the foot, according as it will be judged proper or neceſſary; ſtrengthening her the while with good cardiacks, good broth, made with veal and chickens, and now and then a glaſs of very good wine, mixed with water, provided ſhe has no fever.

Theſe inſtructions are ſufficient for *natural delivery*, I'll paſs to thoſe *relating to preternatural ones*.

There are three ſorts of *preternatural deliveries*, viz. the *laborious*, the *difficult*, and that entirely *againſt nature*.

A *laborious delivery* is that whereby the mother and her child (though he comes into the world in a natural ſituation) ſuffer much.—The *difficult* is no otherwiſe different from the *laborious*, than by its being attended with ſome accidents which retard it, and render it difficult.

But the *delivery againſt nature*, is that which by reaſon of the ſituation of the child, can never be done without the aſſiſtance of the operation of the hand.

The difficulties a delivery is attended with, happen either from the part of the mother, or from the child, and often from both.

If the difficulty proceeds from the part of the mother, ſhe being too young, and too ſtrait; ſhe muſt be handled gently, and her paſſages ſoftned with oil, pomatum, or freſh butter, anointing them with thoſe things long before the hour of her delivery, to relax them, and render them more eaſy to be dilated, leſt a laceration of ſome parts would happen when the child comes into the world.

If the woman be advanced in years, and pregnant of her firſt child, ſhe muſt likewiſe anoint her parts, to ſoften the inward orifice of the matrice, which being harder, cannot be ſo eaſily dilated as in young women, which renders the labour of women advanced in years always much more tedious than that of others.

Little, or ill-ſhaped women, muſt not be put to bed to be delivered, till after the waters are broken; but are to ſtand up, and walk in the room, if their ſtrength permits it, being ſupported under the arms; for thus they will have their reſpiration more eaſy and free, and take a far greater advantage of their pains, than if they were on their bed.

A lean woman muſt humect her parts, by anointing them with oil, pomatum, &c. to render them ſofter, and more ſlippery, that the head of the child may not remain long in the paſſage, nor be compreſſed or bruiſed, by the hardneſs of the bones of the mother which form the paſſage.

A weak woman muſt be cheared up, that ſhe may ſupport the pains of her labour, with ſome good burnt wine or other comfortable things, according to the exigency of the caſe. If ſhe is fearful, ſhe muſt be comforted with the hope of being ſoon delivered; if on the contrary her pains be ſmall, ſhort, with long intervals between, and of a bad ſort, flying back towards the reins, or if ſhe has none, they muſt be provoked by giving her pretty ſtrong glyſters, and other proper remedies: for I moſt commonly preſcribe in thoſe caſes a large ſpoonful or two of a ſtrong tincture of cinnamon, to which I add a few drops of that of ambergreaſe, and three drops of oil of guaiacum; which remedy ſerves likewiſe, when the pains which were very good at the beginning, are quite gone.

If

If the woman has a violent flooding, or convulſions, ſhe muſt be delivered as ſoon as poſſible. If the excrements be retained, and ſhe cannot void them of herſelf, the expulſion thereof muſt be excited by glyſters, for they cauſe violent pains which are needleſs and bad, becauſe they are diſperſed throughout the belly, without forcing downwards. And if ſhe cannot make water becauſe of the exceſſive compreſſion of the matrice on the neck of the bladder, the woman herſelf muſt liſt up her belly a little with her hands, and if it cannot be done otherwiſe, a hollow probe muſt be introduced into the bladder to facilitate the evacuation of the urine. If the difficulty of the delivery proceeds from the bad ſituation of the woman, ſhe muſt be put into another agreeable to her ſhape, obſerving all the circumſtances heretofore mentioned.

If the woman be ſurprized with ſome malady, the cure thereof muſt be undertaken according to the nature thereof, but with ſtill more precaution than at another time:—If it be by reaſon of the indiſpoſitions of the matrice alone, as of its obliquous ſituation, one muſt remedy it as well as he can by that of the body. If it be by its vicious conformation, having its neck hard, callous, and too narrow, it muſt be anointed with oil or pomatum, as above-mentioned. If it was by ſome ſtrong cicatrice which could not be ſoftened, proceeding from an ulcery which had preceded, or of ſome laceration made by a violent delivery, which had likewiſe been glutinated, the ſeparation thereof muſt be made with a proper inſtrument, leſt another laceration ſhould happen in another place, which would render the caſe worſe afterwards; and which muſt be made in the place that is judg'd moſt convenient; avoiding to do it towards the ſuperior part, becauſe of the bladder.

If the membranes of the waters be ſo ſtrong, that they cannot break at the time of the delivery, they may be broken with the fingers, provided the child be then very far advanced at the paſſage, and follows ſoon after that laceration, the inward orifice of the matrice being ſufficiently dilated and well ſoftned; for otherwiſe there would be ſome danger, that the waters being evacuated, the child ſhould remain a long while dry, and one would be obliged to ſupply to it, by bumecting thoſe paſſages, with fomentations of emollient herbs and oils; which has never ſo good an effect as when nature operates of itſelf, by means of the waters.

Thoſe membranes ſometimes advance ſo far out at the pudendum before the child comes out, that they hang the length of more than four fingers breadth, reſembling a bladder full of water; there is then no very great danger to break them, if they be not broken already; for the child is always at the paſſage ready to come out when that happens. One muſt take care not to draw thoſe membranes with the hand, becauſe thereby the after birth, to which thoſe membranes are very adherent, would be ſeparated from the matrice before its time. Sometimes alſo, the waters are inſenſibly evacuated thro' a laceration made inwardly to the membranes of the child, which remaining whole at the fore part of its head, to which they ſerve as a forehead cloth, and line it immediately, hinder it from being forced out by the pains; in that caſe the membranes muſt be broke, provided the paſſage be ſufficiently dilated, that the head of the child may be at liberty to advance into it.

If the *navel-ſtring* falls out of the matrice, it muſt be immediately puſhed back into it, hindering it, if poſſible, from falling out again, otherwiſe the woman muſt be delivered as ſoon as poſſible: but if the after birth falls out, it muſt never be puſhed back into the matrice, becauſe, when once out of it, it is of no uſe to the child; on the contrary, it would be an obſtacle to its birth, if it was puſhed back; in that caſe it muſt be cut off after the navel-ſtring has been tied, and the child taken out as ſoon as poſſible; for if the child was left in the matrice it would be ſoon ſuffocated, if it was not dead already, as it almoſt always happens, when the after-birth, or even the navel-ſtring comes out firſt

When the difficulty proceeds only from the part of the child who is dead, one muſt obſerve the ſame method as in the natural delivery; beſides which the woman muſt make all the efforts ſhe can to force it out, for a dead child cannot help itſelf, no more than when it is extremely weak; taking at the ſame time ſome comfortatives, leſt the putrid vapours which exhale from a dead child, ſhould cauſe her ſome ſyncops. But if the child be ſo hydropſical in its belly or head, that it can never come out becauſe of the great diſtenſion and bulk of theſe parts; then the membranes muſt be broke to evacuate the waters; and if it be of a monſtrous bigneſs in its whole body, or head only, or there be two heads, or it be joined to another child; in thoſe caſes (to ſave the mother) one muſt either dilate the paſſage, in proportion to the bigneſs of the monſtrous child (if ſuch a thing be poſſible) or extract it with the inſtruments, if one be indiſpenſably obliged to it, to hinder the mother from periſhing with her child.

Inſtruments ſhould never be uſed but in caſe of an extreme danger; and when all other means have proved ineffectual, or are judged entirely needleſs.

The obſervations a man-midwife is obliged to make before he undertakes to deliver a woman, are firſt, to take care that the woman has ſtrength

enough

enough to undergo the operation; which he will diſcover, if by feeling her pulſe, he finds it ſtrong or weak, unequal and intermittent; examining beſides her face, and particularly if her eyes be heavy and ſunk, and her ſpeech weak; if the matrice, and all the lower part of her belly be extremely high and inflamed, if all the extremities of her body be cold, if ſhe has frequent ſincops attended with cold ſweats, if ſhe falls into convulſions with loſs of knowledge; and laſtly, if all her countenance indicates that the operation would be needleſs, and is not to be undertook without the imminent danger of the woman dying in the man-midwife's hand.

When a woman has all her ſtrength, the man-midwife conſcious that ſhe is capable to undergo the operation, he muſt place her on her back acroſs the bed, that he may work with more eaſe, her buttocks a little higher than her ſhoulders, or at leaſt her body equally ſituated, when it is neceſſary to turn the child to make it take another ſituation.

But when the child is to be extracted, the woman muſt be placed in the ſituation mentioned, when I have ſpoke of the natural delivery, ſo as to have her head and breaſt a little higher than the reſt of her body, to eaſe her reſpiration, and that ſhe may act her part in the expulſion of the child, by ſtraining and forcing downwards, when the midwife bids her. Thus ſituated, ſhe muſt have her legs folded in ſuch a manner that her heels be pretty near her buttocks, and her thighs ſeparated from one another, and kept in that poſture by two pretty ſtrong perſons; another holding her under the arms leſt her body ſhould follow in the extraction of the child, which is moſt commonly attended with a great effort on the part of the man-midwife, who ſhould make all the deliveries againſt nature, ſetting on a chair of a height proportioned to the ſituation of the woman, the outward entrance of whoſe matrice muſt anſwer to very near the height of the man-midwife's elbow while ſetting, that he may operate with a greater ſecurity and facility, without fatiguing himſelf to exceſs; for when he has once fatigued himſelf in operating, he cannot work afterwards with the ſame dexterity, nor ſo quick.

Thus done, he muſt anoint the whole matrice with oil or pomatum, that he may eaſily introduce his hand into it, which muſt be anointed likewiſe, and have the other conditions above-ſpecified.

In all the *deliveries againſt nature*, which proceed only from the bad ſituation of the child, without being accompanied with any other conſiderable accident, one muſt wait to extract the child, till the matrice be paſſably open, and its inward orifice ſufficiently prepared and ſoftned, particularly if it be a firſt child. Therefore when it is perceived that the child preſents itſelf in a bad ſituation at the beginning of the labour, the membranes which contain the waters muſt not be broken, but at the time the paſſages are found diſpoſed to permit the extraction of the child without much violence; and if the waters are evacuated before the matrice can be ſufficiently open, one ſhould notwithſtanding wait a little the preparation of the paſſages, if there be any appearance of it, without however ſuffering the parts to grow dry by the entire evacuation of the waters. For though the child be in a bad ſituation, it is notwithſtanding ſufficiently vivified by the navel-ſtring while it remains in the matrice, and is not yet much engaged in the paſſage in its bad ſituation; and the mother on her ſide is no otherwiſe incommoded thereby, than by the tedioufneſs of her labour. If a man-midwife ſhould act otherwiſe, the child would be in a much greater danger to periſh in the paſſage at the time of the operation, becauſe of the narrowneſs of the ſpace, which would detain it longer, the operation itſelf be attended with much more difficulty, and the mother treated with more violence.

If by the motion of the child, a man-midwife cannot be ſure that it is alive, when the waters are broke, he muſt ſlide as ſoon as poſſible his hand gently into the matrice, where he'll feel the pulſation of the umbilical arteries, which will be much ſtronger if he touches it very near the belly of the child; or having found one of the child's hands, he'll feel the artery of the wriſt, but it has not then ſo ſenſible a motion as that of the umbilical arteries; if then he feels the pulſation of thoſe arteries, he may be ſure that the child is alive; as likewiſe, if having put the extremity of his finger into its mouth, he feels the tongue ſtir.

But on the contrary, the child is dead, if it has not ſtirred for a conſiderable time; if the matrice voids fetid and cadaverous humidities; if the woman feels exceſſive pains, and a great weight in her belly; if the child falls like a lump always on the ſide ſhe lays; if ſhe has ſyncops, and frequent convulſions; if it is long ſince the navel-ſtring, or after birth is come out; if introducing the hand into the matrice the child is felt cold, his umbilick without pulſation, and its tongue immoveable; and if feeling its head, it is found ſoft, and the bones vacillent; the brain being without pulſation when the child is dead.

But we can only draw conjectures of the death of the child, if the woman has been wounded, if ſhe has a great flooding, if ſhe is not at term; if there be four or five days ſince her waters are broken; if ſhe has a leaden colour, her eyes much ſunk; and a dejected look; if her breath be very bad, her

breaſts flabby, and the bigneſs of the bottom of her belly has been diminiſhing for ſome time, without the evacuation of the waters.

Moſt of the ſigns above-mentioned, as well the moſt ſure, as thoſe by conjectures, muſt meet together to certify that a child is dead, for ſeveral of them are equivocal, when they are alone.

How to help a woman when the child preſents one or two feet foremoſt.

If a child preſents one or two feet foremoſt, place the woman in the poſture heretofore deſcribed for preternatural deliveries, and draw it out in that poſture, in the manner I am going to deſcribe, taking care that both feet belong to one child.

So ſoon as the man-midwife has found the two feet of the child, he muſt bring them out; then taking them with both his hands, above the ankles, and holding them near one another, he'll draw them equally in that manner, till the thighs and hips of the child be extracted, laying hold ſometimes, likewiſe, of the thighs above the knees, ſo ſoon as there will be room to do it, taking care to envelope thoſe parts with a piece of dry cloth, leſt his hands which are greaſy, ſhould ſlip on the body of the child, very ſlippery of itſelf. Which done, holding always the child by its two feet, and above the knees, he'll draw it thus, till the top of the breaſt; after which, he'll pull down, on each ſide, the two arms of the child along its body; obſerving to take them rather by the hands towards the wriſt, than by any other place, and to diſengage them gently, from the paſſage one after another, without forcing them too much, for fear of breaking them; and taking care, then, that the belly and face be directly downwards; to avoid the head being ſtopped at the chin by the *os pubis*; therefore if it was not in that ſituation, it ſhould be turned; which may be eaſily done, if when one begins to draw the child by the feet, they be inclin'd, in turning them by degrees, in proportion as the extraction is made, till its heels regard directly the belly of the woman; and if they were not quite in that ſituation, when the child has been drawn as far as to the top of the thighs, before it be drawn further out, the man-midwife muſt introduce one of his hands, as flat as poſſible, ſo far as to the pubis of the child, and with his other hand hold the two feet, to turn, at the ſame time, its body on that ſide it is the moſt diſpoſed to receive a good ſituation, till it has its breaſt and face downward; and having thus brought it up as far as towards the top of the ſhoulders, he muſt take great care to take his time (bidding the woman to make ſome effort at that very inſtant) that its head may take the place of the feet at the ſame moment they have quitted it, whereby it will not be ſtopped at the paſſage.

When the head of the child ſeparates from its body, and remains alone in the matrice, either by reaſon of putrefaction, or for another cauſe; the man-midwife muſt immediately, without delay, and before the matrice cloſes itſelf, introduce his right-hand into it, and ſearch the mouth of the head (which is the only hold remaining then) and having found it, thruſt one or two fingers into it, and his thumb under its chin, after which he'll draw it ſoftly, holding it thus by the inferior jaw-bone. But if that bone was to part from the head, in the efforts made to extract it, as it happens often when there is putrefaction; in that caſe he muſt take his right-hand out of the matrice, to ſlide the left into it, with which he'll ſupport that head, and with the right take a narrow, but very ſtrong hook, and with a ſingle branch, which he'll ſlide along the inſide of his other hand, turning the point towards it, for fear of wounding the matrice; and thus introduced ſhall turn it towards the head, to run it into the orbit of the eye, or into the holes of the ears, or into that of the occiput, or between the futures, according as he'll find it moſt practicable, endeavouring always to lay hold of the place he'll fix it to, as faſt as poſſible, after which drawing that head thus faſten'd to the hook, and helping with the left-hand to guide it, he muſt make the entire extraction thereof, taking care, when brought near the paſſage, to draw his hand out of the matrice, leſt the paſſage ſhould be ſtreighten'd therewith, leaving only ſome fingers towards the ſide of the head, to diſengage it with more facility, and to hinder the matrice from being wounded by the hook, in caſe it ſhould chance to loſe its hold.

In a caſe of neceſſity, and for want of a hook, take a piece of ſoft tape, three fingers broad, and two yards long, or thereabout, folded in two, and laying hold of both ends with the left-hand, introduce with the right the middle thereof into the matrice, ſo that it may be placed on the hind part of the head, as a ſtone in a ſling; and then drawing the tape by the two ends joined together, make the extraction of the head, without the leaſt fear that the tape ſhould ſtop the paſſage, ſince it takes but very little room.—And, I am of opinion, that this is the ſafeſt manner of making that extraction, and have always preferred it to a hook, with very great ſucceſs.

If notwithſtanding all theſe different manners the man-midwife cannot extract the head, becauſe it is too large, he muſt diminiſh the bigneſs thereof with a bowed knife; introducing firſt his left hand into the matrice, and with the right ſliding likewiſe that knife into it, taking great care in doing it,

it, that the point of the knife be turn'd towards the inside of his left-hand, for fear of wounding the matrice; which done, he'll turn it again towards the sutures of the head, and particularly towards the place of their junction, where he'll make an incision with that instrument; whereby having separated some pieces thereof, he may with a greater facility draw the rest; or at least having emptied part of the brain through the aperture he had made, the bigness of the head being thereby much diminished, the extraction may be less penible.

If the after-birth be quite separated from the matrice, it must be extracted first, otherwise it would be an obstacle to the extraction of the head: but if it be yet adherent to the matrice it must be left in it, till after the extraction of the head; for if the man-midwife was to separate it then from the matrice, there would ensue a very great flooding, which would be increased by the agitation of the operation; for the vessels to which it is joined remain commonly open, while the matrice remains in the distension caused by the head retained in it, and do not close till after it has been delivered of that foreign body; besides which, the after-birth remaining thus fastned during the operation, hinders the matrice from being easily contused and wounded.

How to assist a woman whose child presents itself by the side of the head; *and likewise when it presents itself* with the face foremost.

As soon as it is found that the child presents itself in that bad posture, the woman must be bid to lie down, for fear it would be very difficult to push in the child (as it must be done, to make it take a natural situation) if it was advanced further into the passage.

To perform this operation, the woman must be put in a commodious situation, making her to lean a little on the side opposite to the bad one of the child; then the man-midwife shall slide his hand, well anointed with oil, on the side of the head of the child, to set it right; bringing it, gently, with his fingers, placed between it and the matrice, to a right situation; but if the head was so much engaged, that the thing could not be effected in that manner, he must slide his hand as far as the shoulders of the child, that pushing them back a little into the matrice, he may put him in a natural and convenient situation.

But if the head cannot be reduced, because of the bad situation of the body of the child, which hinders its being set right; then one must have recourse to the last remedy to save the child's life, which is to turn it entirely, by going to fetch the feet, to draw it by them in that same moment.

At other times *the child presents itself with its face foremost*, having its head bent backwards, in which posture it is very difficult to bring it into the world; and if it remains long in it, becomes so livid and puffed up, that he appears monstrous.

A man-midwife must proceed in this delivery in the manner prescribed, when the child presents its head sideways, which must be set right with the hands, observing always to do it as gently as possible, for fear of hurting the face of the child.

The method of delivering a woman, when the body of the child is stopped at the passage by the shoulders, *after the head is come out.*

If the shoulders don't pass after the head has been pulled in a proper manner, the man-midwife must slide one or two fingers of each hand under each arm-pit, with which, bending them inwards, the shoulders will be drawn by degrees; but when they have entered the passage, and are entirely disengaged from it, if he cannot have the child yet, holding it thus under the arm-pits, then it is sure that it is stopped by some other impediment, and is certainly monstrous in some part of its body; or, as it happens often on that occasion, it is hydropsical in the abdomen, which hinders it from being extracted from the matrice, by reason of the eminence and bigness of its belly, without a punction to procure the evacuation of the water; which is done by introducing the left-hand into the matrice, as far as to the place where the belly is, and then running along the inside of the same hand with the right, a hook, or a bowed knife, the point thereof turned towards the belly of the child, that point must be thrust into it at once; and when it is extracted from the hole it has made, two fingers must be introduced into it to dilate it, whereby all the waters are evacuated in an instant; after which the rest of the body of the child stopped in the matrice, is extracted without difficulty.

The manner of assisting a woman in a labour where the child presents one or both hands together with the head.

To give her assistance, if a midwife, or man-midwife, finds that one of the hands presents itself thus, together with the head of the child, he must not be suffered to advance further, and to engage itself more in the passage in that situation; therefore having made the woman to lay down, so as to have her buttocks a little risen, he must push back with his hand, as far as possible, that of the child, or both, if they both present themselves, giving room by that means to the head of the child to advance forwards alone; which done, if the head was sideways, he must reduce it to the natural

ſituation, *i. e.* place it in the middle of the paſſage, to make it come out in a ſtrait line.

How to aſſiſt a woman in labour, when the child preſents one or both hands alone.

This is one of the worſt and the moſt dangerous poſtures it can preſent himſelf in, either for itſelf, or for the mother.

Therefore the woman having been placed in a proper ſituation, the hands or arms of the child which preſent themſelves at the paſſage, muſt be quickly puſhed back into the matrice, the man midwife ſliding afterwards his hand into the matrice, under the breaſt and belly of the child, and ſo far that he may reach the feet, which he'll draw gently to himſelf to turn it, and extract it by them; taking care to do it with as little violence as he can; without amuſing himſelf to give the child a natural ſituation; which it would be very difficult to do, becauſe he has his whole body croſs-wiſe, when he preſents thus an arm alone, as far as the elbow or ſhoulder; obſerving when he thus introduces his hand into the matrice, that he muſt ſlide it inſide of the membranes of the child, and not between the membranes and the matrice; for thoſe membranes, which line the whole inſide of the matrice, facilitate by their poliſhed ſlippery ſubſtance, the turning of the child, and hinder, by their interpoſition, the matrice from being hurt by the hand of the man-midwife in the operation.

As ſoon as the man-midwife has thus turned the child by the feet, if he was to lay hold but of one, he muſt ſearch the other to bring it along with the firſt; that holding both, he muſt govern himſelf in the extraction of the child, in the manner deſcribed for the delivery where the child preſents his feet foremoſt.

But if the arm was ſo far advanced, ſo big and ſo tumefied, that he could not be put back without much difficulty, *Ambroſe Paré* adviſes, if the child is dead, to cut the arm, as far as poſſible; though it is far better, and ſafer to wring it off, becauſe its being very tender, it will be eaſily ſeparated from the body, at the articulation of the *humerus* with the ſhoulder-bone. But when a child is to be mutilated thus, or extracted with a hook, the man-midwife muſt be very ſure that it is dead.

How to deliver a woman when the child preſents its feet and hands.

If the child preſents its hands and feet together, it is abſolutely impoſſible it ſhould come out in that ſituation; therefore the man-midwife carrying his hand towards the orifice of the matrice, will feel nothing but a quantity of fingers near one another; and if the matrice be not well open yet, he will not be ſo ſoon able to diſtinguiſh preciſely the feet from the hands, becauſe they are ſo cloſe together, that they ſeem almoſt all of the ſame figure. But ſo ſoon as the matrice will be dilated enough for to introduce the hand into it, he'll diſtinguiſh eaſily which are the hands, and which the feet; and then he'll ſlide it as far as towards the head of the child, which he'll find pretty near, he'll puſh it back gently, together with the hands towards the bottom of the matrice, leaving the feet in the ſame place where he has found them; then placing the woman in a commodious ſituation, *i. e.* her buttocks a little riſing, he'll take the child by both feet, and draw it in the manner heretofore deſcribed, when I treated of extracting a child by the feet.

How to deliver a woman when the child preſents its knees.

Having diſcovered that it is the knees the child preſents, don't ſuffer it to advance further; but having placed the woman in a convenient ſituation, puſh the knees of the child gently back into the matrice, to be more at liberty to unfold its legs one after another; which to effect, put one or two fingers under the ham, and guiding it ſlowly along the hind part of the leg, which draw always a little obliquely, till you have found the foot, that having diſengaged one of them, do the ſame to the other, proceeding in the ſame manner, as done to the firſt, after which having drawn them both out, make the extraction of the child, as if it was to come the feet foremoſt; obſerving always to extract it the face downwards.

Of a delivery where the child preſents the ſhoulder, back, or buttock.

To perform the operation, where the ſhoulder preſents itſelf firſt, the man-midwife muſt puſh, with his hand, the ſhoulder a little back into the matrice, that he may with greater facility introduce his hand into it; and ſliding it afterwards along the body of the child, on the ſide he'll find the thing more eaſy, he'll ſearch the feet, to turn the child entirely in bringing them to the paſſage; after which he'll extract it, as it is done when the child preſents the feet foremoſt.

If the child preſents its back foremoſt, the man-midwife muſt ſlide his hand along the back towards its lower part till he has found the feet of the child, extracting it afterwards, as when it preſents its feet.

But when the child comes the buttock foremoſt: if it be ſmall or of a middle ſize, and the mother tall, having the paſſage pretty large, it can very well come out in that poſture, with a little help; for though it has then its body bent, the thighs being folded towards the belly, which is ſoftiſh,

force

force their paſſage over-againſt it, without much difficulty. Which, notwithſtanding, as ſoon as the man-midwife has diſcover'd that the buttock of the child preſents itſelf foremoſt, he muſt next puſh back the buttock, if he can do it without violence; and ſliding afterwards his hand along the thighs, as far as the legs and feet of the child, he muſt bring them gently, one after another, out of the matrice, unfolding, extending and turning them towards the moſt eaſy ſide; taking great care to do it, without any contorſion or diſlocation; and extracting the reſt of the body, as if the child was to come with its feet foremoſt.

The child is ſometimes ſo far advanced into the paſſage with its buttock foremoſt, that it is abſolutely impoſſible to puſh it back, and therefore muſt neceſſarily come into the world in that bad ſituation; but to help the child to it, the man-midwife muſt ſlide one or two fingers of each hand on the ſide of the buttocks, to introduce them towards the groin, as ſoon as he'll be capable to do it without violence, and having bent them inwards, he muſt draw the backſide out as far as the thighs; then drawing them a little obliquely on one ſide and the other, he'll diſengage them from the paſſage, as likewiſe the legs and feet one after another, without fracture or diſlocation, ending afterwards the extraction of the reſt of the body, as if it was to come the feet foremoſt.

A man-midwife muſt take particular care, when he extracts a child, who preſents the backſide foremoſt, to bring it out with its face downwards; for commonly when it comes out the backſide foremoſt, it has the face and feet towards the belly of the mother: and if it was drawn in that manner, in a direct line, without turning it by degrees, in proportion as the extraction goes forwards, the face being thus upward, the chin of the child would be faſten'd underneath the *os pubis*, and the head ſtopped at the paſſage, where it would ſoon periſh.

Of a delivery, where the child preſents the belly, the breaſt, or the ſide.

To prevent all the dangerous conſequences ſo unſafe a labour could be attended with; the operator, after he has placed the woman in a convenient ſituation, muſt run gently his hand, well anointed with oil or pomatum, towards the middle of the breaſt of the child, to turn it quite, (becauſe in that ſituation it is half turned) then ſlide his hand under the belly, till he has found the feet of the child, which he muſt bring to the paſſage, to draw it out in the ſame manner, as if it had preſented its feet foremoſt.

When the child preſents the breaſt, or the belly foremoſt, the man-midwife muſt proceed in the ſame manner, in both occaſions.

The child can alſo preſent itſelf ſideways; which is not ſo dangerous a ſituation as the two others, becauſe it does not die ſo ſoon. To deliver a woman when the child preſents itſelf in that ſituation; the woman being placed in a convenient poſture, the operator muſt puſh a little back the body of the child, that he may introduce his hand with more facility into the matrice, which he ſhall ſlide along the thighs till he has found the legs and feet, by which he'll turn it, and extract it afterwards.

Of a labour where there are ſeveral children, who preſent themſelves in the different poſtures heretofore mentioned.

When two children preſent themſelves both in a bad ſituation; or when but only one of them preſents itſelf in a bad ſituation, as it moſt commonly happens, the firſt coming head foremoſt, and the ſecond the feet foremoſt, or in ſome other ſtill worſe poſture, the operator muſt, as ſoon as poſſible, procure the birth of the firſt, that immediately after, he may go ſearch the ſecond, to draw it by the feet, without attempting to give it a natural ſituation, was he even diſpoſed to it, becauſe the child has been ſo much fatigued and debilitated, and likewiſe the mother, during the coming out of the firſt, that it would be often in danger of dying before it could come out.

Sometimes, likewiſe, after the firſt is come out naturally, the ſecond preſents itſelf the head foremoſt. In that caſe, nature muſt be left to accompliſh the reſt, providing ſhe be not too long about it; for the child might chance to die, though in a natural ſituation, through the tediouſneſs of the labour: and the woman who has been much tormented to bring the firſt child into the world, is commonly ſo fatigued, and ſo much diſcouraged, when ſhe knows, that after ſhe has ſuffer'd ſo much, ſhe has done yet but half her work, loſes courage, and is beſides ſo much weaken'd and debilitated, that ſhe has no more pains, or but very ſmall ones. Therefore, when the man-midwife ſees that the labour is too long, he muſt introduce his hand into the matrice, to ſearch the feet of the child, to bring it out that way; and if the waters were not broke yet, he muſt make no difficulty to lacerate the membranes with his fingers; and it is even better to do it ſoon after the firſt is come out, who having then made the paſſage, the coming out of the ſecond is thereby accelerated.

So ſoon as the operator ſhall have brought the firſt child into the world, he muſt ſeparate it from the after-birth, by tying and cutting the navel-

ſtring,

ſtring, taking afterwards the feet of the other to bring it out in the ſame manner: after which he'll draw the after-birth to extract it with the help of its two navel-ſtrings.

Of the delivery where the navel-ſtring comes foremoſt.

Every time the *navel-ſtring* comes out firſt, the child does not always preſent the belly; for though it comes out naturally, as to the figure of the body, *i. e.* the head foremoſt, the navel-ſtring notwithſtanding falls ſometimes, and comes out firſt; and then the child is in a great danger of his life, unleſs the woman be quickly delivered.

To remedy that accident, and prevent, if poſſible, the fatal conſequences it is attended with, the patient muſt be kept in her bed very warm, and the navel-ſtring immediately put back into the matrice to hinder it from cooling, endeavouring to thruſt it quite behind the head of the child, if the head preſents itſelf foremoſt, leſt it ſhould be preſſed and contuſed by it, and the motion of the blood intercepted; keeping it faſt, by means of the ends of the fingers of one hand, in the place whereinto it has been puſhed, keeping always thoſe fingers on the ſide it comes out at, till the head be entirely come down and lodged at the paſſage, can hinder it from falling another time, taking the occaſion of a good pain, to bring it to it with more facility; or if the operator draws out his hand, he muſt thruſt a ſmall piece of very ſoft linen between the ſide of the head and the matrice, to ſtop the place through which the ſtring could fall, obſerving to let one end of that linen hang out, that it may be extracted when it is judged proper; putting likewiſe a compreſs dipped in hot wine, before the entrance of the matrice, to hinder the navel-ſtring from cooling, in caſe it was to fall again.

But, notwithſtanding all thoſe precautions, it happens ſometimes, that the navel-ſtring falls at every pain, which the woman takes: in which caſe the operation ought not to be deferred, but the child muſt be extracted as ſoon as poſſible by the feet, which the man-midwife muſt go to ſearch, was even the head to preſent itſelf firſt, ſince there is but that ſole remedy, which can ſave its life.

Therefore having placed the woman in a commodious ſituation, he muſt puſh back gently the head of the child, which preſents itſelf firſt, if it be not too far advanced between the bones of the paſſage, and he can do it without tormenting the woman too much; in which caſe it is beſt to leave the child in danger of its life than to expoſe that of the mother. Afterwards he'll ſlide his hand (we'll anointed with oil or pomatum) under the breaſt and belly of the child to ſearch its feet, by which he'll draw it out.

Of a delivery where the after-birth preſents itſelf foremoſt, or is entirely come out before the child.

When the after-birth preſents itſelf firſt at the paſſage, nothing is felt but a ſoft body, without any ſolid part; and the blood flows in abundance from the matrice with ſeveral clods, the woman fainting away often.—In that deplorable caſe, the operator muſt make haſte to deliver the woman, if he will ſave her life, and that of her child, if it be yet alive. If the operator was to find that the after-birth is almoſt quite out of the matrice, and the membranes thereof entirely broken, or lacerated, he muſt extract it quite.

Of a delivery accompanied with a great loſs of blood, or, with convulſions.

A quick delivery is the moſt ſalutary remedy in that dangerous caſe, and the man-midwife muſt procure it as ſoon as poſſible; which ſhould be done in the following manner.

If the child be ſuppoſed alive, though it preſents itſelf in a natural poſture, the operator muſt turn it entirely in the matrice, to draw it out by the feet, after having broke the membranes of the waters, if they were not broke already.

If on the contrary the child is known to be dead, and its head is too ſtrongly engaged in the paſſage, the operator muſt make no difficulty to draw it with the hook.

To avoid and prevent ſo dangerous an accident, thoſe ſort of women muſt be let blood twice or three times during their pregnancy, and likewiſe at the beginning of their labour, in order to diminiſh the quantity of blood of which their veſſels are too full, and which is the cauſe in part of the convulſions, by flowing to the head, by reaſon of the extenſive pains a labour is attended with.

How to deliver a woman when the child is hydropſical, or monſtrous.

If the hydropſical child be alive at the time of the delivery, its life cannot be ſaved; for to ſave that of the mother, its head muſt be pierced, or its breaſt, or its belly, *i. e.* that part where the water is contained, to procure the evacuation thereof, without which it could not be extracted, and remaining in the matrice, would kill its mother: therefore to ſave her life, it is abſolutely neceſſary to extract the child by art, which is done in the following manner.

Of the extraction of a dead child.

Before the man-midwife undertakes the operation, he muſt endeavour to excite ſome labour pains, by means of ſtrong glyſters, to facilitate the expulſion of the child, if it be in a good ſituation;

tion; but if thoſe remedies have no effect, he muſt proceed to the extraction of the child; which is the ſureſt means; for all the other remedies taken inwardly, and preſcribed by ſome phyſicians, to facilitate the expulſion of a dead child out of the matrice, being commonly very hot, and purgatives, can cauſe afterwards very dangerous accidents, as a fever, looſeneſs, dyſentery, loſs of blood, relaxations, and bearing down of the matrice.

The extraction of a dead child is made, by puſhing back the head of the child (if it comes foremoſt, and is not too much engaged in the paſſage) into the matrice, that the operator may have the liberty to introduce his right hand into it, ſliding it under the belly of the child, to ſearch its feet, in order to turn and draw it in the manner abovementioned: taking great care that the head ſhould not be ſtopped, nor ſeparated from the body at the paſſage.

But if the head of the child was ſo much engaged in the paſſage, that it could not be puſhed back, then the operator, if he be very ſure that it is dead, ſhall extract it in that poſture, by means of a hook, which he muſt puſh as far as poſſible, without violence, between the matrice and the head of the child, guiding it along the inſide of one of its hands, its point turned towards the head, which he'll hook in, by fixing it, if poſſible, on the ſkull; in ſuch a manner, that it may not ſlip, or part from its hold. This hook being thus well faſten'd to the head, he muſt draw it out, placing the extremity of the fingers of his left hand on the ſide oppoſite to the hook, to help to diſengage it better, in ſhaking it a little by degrees, and to guide it more directly out of the paſſage; uſing then, if it be neceſſary, a ſecond hook, in the ſame manner as the firſt, and placing it on the oppoſite ſide of the head, that the extraction be made equally on both ſides.

But the extraction of a dead child is made with a ſtill greater facility, by means of an inſtrument of the invention of the famous M. *Mauriceau*, which he calls *a head ſcrew*.

But if the dead child was to preſent an arm as far as the ſhoulder, and ſo much ſwelled and tumefied, that it could not be puſhed back into the matrice, without hurting much the woman, it muſt be ſeparated from the body, by twiſting it three or four times, as already deſcribed; whereby occupying no longer the paſſage, the operator will have more room to introdoce his hand into the matrice, to fetch the feet of the child, to extract it by them; obſerving always, when he has made the extraction of a dead child, to re-aſſemble into one all the parts he has ſeparated, to ſee if he can compoſe a whole body of them, and diſcover thereby if nothing remains in the matrice.

So ſoon as the woman has been delivered of her after-birth, the midwife muſt take great care that its ſeparation be not followed by a too great loſs of blood; and place before the entrance of the matrice a pretty ſoft cloth, folded into five or ſix doubles, leſt the cold air penetrating into it, ſhould ſtop the evacuation of the lochia, by a too ſudden obſtruction of the veſſels; the ſuppreſſion whereof would be unavoidably attended with very dangerous accidents, as exceſſive pains, and gripings in the belly, inflammation of the matrice, a fever, pleuriſy, and ſeveral others, and perhaps death itſelf.

The entrance of the matrice being thus well ſtopped, if the woman has not been deliver'd in her bed, ſhe muſt be immediately carried into it, unleſs there was a flooding, as it happens ſometimes, for then ſhe ſhould be left above a quarter of an hour, in the place where ſhe has been deliver'd, leſt by moving her ſo ſoon, the loſs of blood ſhould increaſe: which, on the contrary, is moderated, by the air, which introduces itſelf into the matrice; while other remedies are adminiſter'd to the ſame purpoſe. But if there be no fear of that accident, the woman muſt be carried to her bed, by one or two perſons, rather than be ſuffer'd to walk to it; though if there was ſome part of the after-birth left behind, that walking (provided it was not too far) would contribute to the expulſion thereof. The bed having been made, as requiſite in thoſe occaſions, and well warmed before ſhe is put to it: where ſhe muſt be placed in a ſituation, with her head and body a little riſing, as well to facilitate her reſpiration, as to procure the evacuation of the blood, which flows then, and which being intercepted, would cauſe violent pains to the poor patient.

The moſt common cuſtom, is to give to the woman, ſoon after ſhe is in bed, a ſpoonful of *ſperma ceti*. Others give her only ſome good broth, which they think better. Then the patient is left to take ſome reſt.

If the woman is not to ſuckle her child, there muſt be remedies applied on her breaſts, to diſſipate the milk; but if ſhe deſigns to do it, her breaſts ſhould be only kept cloſe, and cover'd with ſoft and warm cloths for fear the milk ſhould grow knotted; and if it flows into it with too much impetuoſity, embrocations are to be made on them, with oil and a little vinegar mixed together, dipping in it ſome cloths to apply on them; obſerving, if the woman will ſuckle her child, that ſhe ſhould not give it the breaſt but three, or even five days after ſhe is deliver'd, *i. e.* till the humours,

mours, which have been in a great ferment, and flow in great abundance to the breaſts, in the firſt days, be much abated.

As to the regimen a lying-in woman is to obſerve, when no accidents happen.—She muſt be treated in the firſt days, with regard to her diet, as if ſhe had a fever; therefore ſhe ſhould be fed, particularly during the three or four firſt days, with chicken-broth, jellies, and the like; and likewiſe ſome boiled and even roaſted chickens, provided it be in a moderate quantity.—As for her drink, ſhe may be ſuffer'd, if ſhe has no fever, to drink ſome white wine, mixed with warm water, for ſhe is not to drink any thing cold.

The loſs of blood is an accident more dangerous than all the others, which can happen to a woman newly deliver'd, and ſometimes cauſes her death, before one has time to remedy it: therefore proper remedies muſt be adminiſter'd to the patient, as ſoon as poſſible, examining what can be the cauſe of ſuch a flooding; for if it be a falſe conception, or a portion of the after-birth, or ſome clods of blood left behind in the matrice, they muſt be immediately extracted, or the expulſion thereof procured by ſome ſpecifick remedy; ſuch as *a few drops of the oil of guaiacum in plantain-water.* But if the blood flows immoderately, though there be nothing left behind in the matrice, the woman muſt be let blood in the arm, if her ſtrength will permit. Her belly muſt not be kept tight at all, eſpecially if ſhe feels pains in it; neither is ſhe to be much cover'd in her bed; and care ſhould be taken, that the air of her chamber be a little cooled; warming, likewiſe, the region of the heart with hot cloths, aromatized with *Hungary* water, or ſome other proper liquor. She muſt take every half hour, a few ſpoonfuls of good broth, or one or two of good old red wine.

The fall of the matrice, which happens immediately after the delivery, can cauſe the death of the woman in a few hours, if it be not immediately reduced into its proper place.

For the cure of this dangerous malady, a man-midwife muſt have regard to two things:—The firſt is to reduce the matrice in its proper place:—And the ſecond to keep it up and ſtrengthen it.

To *reduce the matrice*, if it be entirely fallen, the operator muſt, previouſly to any thing elſe, procure the evacuation of the urine, and likewiſe that of the coarſer excrements by means of a gentle glyſter, that the reduction thereof may be performed with more facility. Afterwards, the woman muſt be placed on her back, with her thighs a little higher than her head: then all that comes out at the pudendum, muſt be fomented with warm wine or milk; and afterwards it muſt be puſhed back gently with a ſoft cloth, and if the thing be very painful, by reaſon that what is already come out is very big and tumefied, it muſt be anointed with oil of ſweet almonds, to make it ſlide eaſier; obſerving, after the reduction is made, to wipe off that oil as clean as poſſible, to prevent a recidive.

The beſt means to keep the matrice in its natural ſituation, is to place a *peſſary* in the vagina, obſerving notwithſtanding that the bearing down of the matrice, where the inward orifice does not come out at the labia of the pudendum ſo as to be ſeen, wants no *peſſary*.

When the matrice evacuates its lochia, the beſt remedy to ſtrengthen it, is to keep it in its natural ſituation, by means of a *peſſary*; abſtaining in thoſe caſes from keeping her belly tight; obſerving likewiſe to abſtain from coition during the whole time.

It happens alſo, ſometimes, that by the violent efforts the woman makes during her labour, the anus is entirely puſhed out; in that caſe, if the child be very far advanced in the paſſage, the midwife ſhall content herſelf, before that accident happens, to hinder it, if ſhe can, by deſiring the woman not to make ſuch violent efforts; but if it be entirely fallen, as ſoon as the woman is delivered, the reduction thereof muſt be made in the ſame manner of that of the matrice, by fomenting, ſtewing, and anointing the part, if it be neceſſary.

As to the *hæmorrhoides* or *piles*, wherewith lying-in women are troubled, they muſt be anointed morning and evening with an unguentum made of populeum, and oyſter-ſhells calcined; which I know to be a ſpecifick remedy in that caſe.

As ſoon as the woman is delivered, if there be but ſimple contuſions and ſcratches, there muſt be applied on the lower parts to appeaſe the pains, a ſmall cataplaſm made with new-laid eggs, the yolk and white mixed with oil of ſweet almonds, done on hot embers, or on a very ſlow fire, and ſtirred till the whole be pretty well mixed together; then having been ſpread on very ſoft tow or linen, it muſt be applied over all the outſide of the vulva, and remain there during five or ſix hours; after which it muſt be taken off to apply on each labia, ſmall pieces of cloth dipped in oil of St. John's-wort, renewing them four or five times a-day, and waſhing thoſe parts with barley-water and honey, to cleanſe them of the excrements, which flow from the matrice; and when the woman ſhall want to make water, they muſt be covered with a piece of cloth, to hinder the urine from hurting them. But if thoſe lacerations be very painful, the balſam of *Peru* is, in my opinion, preferable to any other remedy.

It

It happens ſometimes, that all the inferior part of the fleet is lacerated, by the child coming out, as far as the anus, whereby both holes are made into one. To rectify this great diſorder, which otherwiſe would be very troubleſome to the woman, and loathſome to the huſband, the re-union of the parts thus lacerated muſt be made immediately after the delivery, by waſhing firſt with ſtrong red wine, made warm, all the place lacerated, and making to it afterwards, a pretty ſtrong ſuture, of one, or two, or more ſeparated ſtitches, according to the length of the ſeparation, and taking at every ſtitch a pretty deal of fleſh, to hinder it from parting. This done, the wound muſt be dreſſed with the balſam of Peru, or that of arceus, covering the whole with a cloth, to prevent the urine from reaching to the part. And that thoſe parts may re-unite with more facility, the woman muſt keep, always her thighs joined together, till the cure be perfected.

All ſorts of *after-pains* are to be remedied, according to their different cauſes.—Therefore to prevent the *after-pains, excited by wind*, the woman muſt take, ſoon after ſhe is delivered, either half an ounce of oil of ſweet almonds, and an equal quantity of ſyrup of maiden hair, mixed together, or ſome ſperma ceti, or fifty drops of oil of anniſeed, with ſome ſyrup of marſh-mallows; or ſome good broths.

Women of quality in *France*, take moſt commonly, after they are delivered, ſome broth, made of an old partridge, boiled together, pretending that ſuch broth has a particular virtue to appeaſe the *after-pains*; others prefer boiled milk, in which are mixed two or three walnuts, pounded with ſome ſugar; ſtraining the whole mixture, very hot, through a cloth.

If the *after-pains* proceed from a foreign body being left in the matrice, the expulſion thereof muſt be procured, or it muſt be extracted by introducing the fingers into its entrance, as I have ſaid, in ſpeaking of the extraction of a falſe conception; or if it be great clods of blood, which being likewiſe ſtopped in the matrice, cauſe thoſe pains, they infallibly ceaſe, ſo ſoon as they are expelled or extracted.

When a woman has a ſudden ſuppreſſion of her lochia, which flowed at firſt in abundance, that ſuppreſſion cauſes always *after-pains*; and the moſt ſalutary remedy is to procure the evacuation thereof; which is done by hot glyſters, and aperitive fomentations on the genital parts, and by bleeding in the foot.

As to the pains which the woman may feel *in the loins and groins*, proceeding from the too great diſtenſion, or rupture in that part of the ligaments faſtened towards thoſe places, repoſe alone, and a good ſituation of the body, will ſuffice to ſtrengthen and conſolidate them, without any other remedy.

To procure or facilitate the evacuation of the lochia, the woman muſt be eaſy in her mind; lie on her back, with her head and breaſt a little riſing, keeping herſelf very ſtill, that the humours may be the eaſier carried downwards by their natural propenſity; ſhe muſt alſo obſerve a good regimen, uſing rather boil'd than roaſted meat, for fear of a fever, abſtaining from all things which are aſtringent; and drinking by intervals, ſome glaſſes of hyſterick and penny-royal waters, mixed together, and warm glyſters ought to be adminiſter'd to them to draw the humours downwards; bathing the lower parts with an emollient and aperitive decoction; made of mallows, parietary, camomile, melilot, roots of aſparagus, and linſeeds; making, with the ſame decoction, an injection into the matrice; and of the herbs, after they have been well boiled, ſo as to be eaſily ſtrained through a ſieve, a cataplaſm, to which muſt be added oil of white lilies, or axonge of pork, which muſt be applied hot on the lower abdomen, heating it from time to time, in the ſame decoction: beſides which, ſtrong frictions ſhall be made on her thighs and legs, particularly towards the inſide; without forgeting bleeding in the foot, or in the arm, according as the accidents cauſed by the ſuppreſſion of the lochia require it. Though, in my opinion, a few drops of oil of cinnamon, in a glaſs hyſterick and penny-royal waters, ſeveral times reiterated, if the accidents require it, anſwer very well in thoſe caſes all the intentions of a man-midwife.

The *ulcer of the matrice*, is abſolutely incurable, either becauſe it cannot be extirpated, as that of the breaſts, or becauſe the matrice receives continually the ſuperfluities of the whole body of the woman; whereby the malignity of the ulcer increaſes daily, notwithſtanding all the remedies which can be uſed during that cruel malady, which never ends but by the death of the patient.

Of what nature ſoever the *looſeneſs* of a woman newly delivered may be, and from what cauſe ſoever it may proceed, it is always of a bad conſequence, and often puts the woman in great danger of her life, becauſe it hinders the evacuation of the lochia of the matrice; which being ſuppreſſed cauſes always very dangerous accidents, and but too often death itſelf. What's the moſt fatal in this malady is, that all remedies proper to ſtop a looſeneſs, increaſe always the ſuppreſſion of the lochia; and thoſe which can procure the evacuation of the ſuppreſſed lochia, increaſe the looſeneſs; therefore a phyſician don't dare to preſcribe any

aſtringent to be taken inwardly; neither is the patient to be purged at the beginning of her lying-in. Notwithſtanding which, one muſt endeavour as much as is poſſible at that time, to adminiſter ſome remedies proper for that malady, by giving the patient ſome good broth to reſtore her ſtrength, much impaired by the looſeneſs. Some ſpoonfuls of mutton juice (extracted in balneo mariæ, or between two deep diſhes without water, and without the leaſt Fat) given by intervals to the patient, I know by practice to be a ſpecifick in that malady; giving her likewiſe, if the looſeneſs continues, ſome drops of laudanum. But if the looſeneſs be accompanied with a fever and other accidents, the patient muſt be let blood in the arm to ſupply the want of purgatives; and if the looſeneſs puts her in greater danger of her life than would do the ſuppreſſion of the lochia, all the remedies uſed at other times for that malady, are to be adminiſtred then; and the looſeneſs being ſtopped, the evacuation of the lochia, which had been ſuppreſſed, is to be procured as well as one can.

Whatever may be the cauſe of the *inflammation of the breaſts* of a lying-in woman, proper remedies muſt be applied to it, as ſoon as poſſible, leaſt they ſhould break out, or for want of ſuppuration, remain in them a ſcirrhous hardneſs, which, in proceſs of time, would degenerate into a cancer.

The principal and ſureſt means to hinder the humours from being carried in too great abundance to the breaſts, is to procure a good and ample evacuation of the lochia, through the matrice; for by that evacuation, all the humours will take their courſe towards the lower parts.

The cure is began by bleeding in the arm, to empty the too great plenitude of the veſſels of the whole body; proceeding to that in the foot, for a greater diverſion of the humours, and to make the lochia flow in greater abundance; during which, topick remedies are to be applied on the breaſts, *viz.* at the beginning, embrocations of oil of ſweet almonds and vinegar mixed together, applying afterward emplaſters of the cooling cerat of *Galian*, with one third of populeum; and if the pain was very great, a cataplaſm muſt be made of crumbs of bread and milk, adding to it oil of ſweet almonds, and ſome yolks of eggs, putting over it compreſſes dipped in *oxyerat*, or plantain water; obſerving, however, that the remedies applied on the breaſts be only cooling and refraining, without any great aſtriction; otherwiſe they would cauſe a ſcirrhous tumour, which would continue a long time, and perhaps degenerate at laſt into a worſe malady.

When the greateſt rage of the inflammation is over, and moſt of the antecedent humour is evacuated, one muſt uſe reſolutive remedies, to digeſt, diſſolve, and conſume the milk, which is in the breaſt in too great abundance; for fear it ſhould be corrupted by ſojourning in them. Therefore it muſt be evacuated, either by the child, or ſome other perſon ſucking it, or by reſolution, otherwiſe it ſhould be evacuated by ſuppuration. Though it is beſt to diſſolve it, than draw it in that manner, when the women does deſign to ſuckle her child; for ſuckling draws other milk to the part, which would cauſe the ſame accident, if it was not evacuated in its turn.—But if the milk chances to flow of itſelf from the breaſts, it muſt not be ſtopped; becauſe then an evacuation thereof is made without attraction.

The diſſolution of the milk is made by applying on the breaſts a cataplaſm of honey alone; or by rubbing red cabbage leaves with it, which muſt be applied on the breaſts, after they have been a little ſoften'd over the fire, and have been ſeparated from their large ribs; taking great care not to preſs the breaſt too hard, and that the cloths put upon it be very ſmooth, without any pleats or ſeams. A very good remedy for the ſame diſtemper, is to boil a red cabbage whole in river water, till it be very ſoft, and there be but very little water left, after which it muſt be pounded a little in a wooden or marble mortar, to ſtrain it through a ſieve, like pap, and make it afterwards into a cataplaſm, adding to it ſome honey, and oil of camomile, which cataplaſm is to be put on the breaſts.

While the woman is under cure, ſhe muſt obſerve a cooling regimen, and very little nouriſhing, to hinder the generation of too much blood and humours, of which there is already a too great abundance. Her body ought to be kept open, that the humours, which otherwiſe would flow to the breaſts, may be carried downwards. During the whole time the inflammation will laſt, ſhe muſt keep her bed, and lay on her back, that ſhe may reſt better.

So ſoon as a woman perceives that ſhe begins to have ſore nipples, it would be very proper ſhe ſhould abſtain from ſuckling her child, till they be quite cured; during which the milk muſt be diſſipated for ſome time, for fear of an inflammation in her breaſt, proceeding from a too great abundance of milk; notwithſtanding which, if there was but one nipple ſore, ſhe could very well give the other to her child.

There muſt be applied on the ſore nipples, ſome oil of eggs, or oil of new wax, for ſeveral days ſucceſſively; uſing afterwards deſiccative remedies, as aluminous, and lime-water, bathing them

firſt with plantain-water only, and applying over it bits of very ſoft cloth, dipped in the aluminous and lime-water; but, in my opinion, the beſt remedy is either cream, or honey of roſes, eſpecially when the nipples are not yet exceſſively ſore.

No better remedy can be adminiſter'd to a lying-in woman, during the paroxiſms of the hyſterick paſſion, than a glaſs of hyſterick, or cinnamon water, or if ſuch a thing is not to be found, a ſpoonful or two of brandy, or a glaſs of wine; I have alſo preſcribed with great ſucceſs, twelve drops of ſpirit of ſal-ammoniack, more or leſs, according to the violence of the paroxiſm.

So ſoon as the woman is delivered of the after-birth, the midwife having put at the entrance of the matrice a cloth folded into ſeveral doubles to hinder the air from penetrating into it, ſhall take a ſtrong thread in four or five doubles, of the length of a quarter of a yard or thereabout, tied with a ſingle knot, at each end; with this thread ſhe ſhall tie the navel-ſtring, at a finger's breadth from the belly, with a double knot, at firſt, then turning the two ends of the thread on the oppoſite ſide, ſhe'll make there another double knot, reiterating the ſame thing, if it be neceſſary, for a greater ſafety; which done, the navel-ſtring muſt be cut at another finger's breadth from the ligature, on the ſide of the after-birth, ſo that there remains of the navel-ſtring only the length of two fingers breadth, in the middle whereof the ligature is made; which muſt be ſo tight, that not one ſingle drop of blood may run from the veſſels, but not too much, for fear the ligature ſhould cut the ſaid veſſels; therefore the thread ſhould be a little big for that purpoſe, and tied with ſome ſort of mediocrity, tho' it is beſt it ſhould be rather tight than looſe. The end of that umbilick, thus tied and cut, muſt be wrapped in a dry piece of cloth, anointed with ſome freſh butter, or oil of roſes; then having put another ſmall piece of cloth, in double, on the belly of the child, towards the ſuperior part thereof; the umbilick, thus wrapped, muſt be placed upon it, the end thereof upwards, that, in caſe the veſſels were not tied tight enough, the blood ſhould not ſo ſoon be loſt, and unperceived, as it would if that end was placed downwards; for it happens, ſometimes, that the navel-ſtring is ſo big, in ſome children, that though it has been tied ever ſo tight, at firſt, the ligature, notwithſtanding, happens to ſlack, when it begins to wither and dry, whereby the blood would flow, if it was not well minded. In that caſe, therefore, in proportion as the umbilick withers, it muſt be tied with a new knot.

The umbilick thus tied withers daily, and moſt commonly falls out at the end of ſix or ſeven days, ſometimes ſooner, and never later than the eighth or ninth day. It muſt always fall of itſelf, without exciting it to it, for fear that was it to fall too ſoon, and before the veſſels are entirely cloſed and re-united, there ſhould happen a flux of blood, which would prove very dangerous; or an ulcer ſhould be left, very difficult to cure. With which obſervation I conclude this treatiſe.

MINERALS.

MINERALS are compound foſſils, wherein there is ſomething diſcovered in all reſpects like metal, only that it is not malleable; joined or compounded with ſome other foſſil, as *ſalt*, *ſulphur*, *ſtone*, or *earth*.

Thoſe *minerals* are *antimony*, *cinnabar*, *biſmuth*, *calaminaris*, *vitriol*, *pyrites*, *marcaſites*, *cobalt*, *oker*, the *magnet*, *lapis hæmatites*, *armenus*, and *ſtellatus*.

ANTIMONY is what we properly call a *ſemi-metal*; being a foſſil glebe, compoſed of ſome undetermined metal, combined with a ſulphureous and ſtony ſubſtance. So that I conſider it as the droſs or ſcoria of other metals, ſeparated from them in their preparation in the matrice.

Antimony is found in mines of all metals, but chiefly thoſe of ſilver and lead: that in gold mines is uſually held the beſt. It has alſo its own mines: that of *Hungary* is the beſt, being full of long needles.

Antimony is found in clods or ſtones of ſeveral ſizes, bearing a near reſemblance to black lead, only that it is lighter and harder; whence alſo it is called *marcaſite of lead*, but very improperly, and its metalline parts ſuppoſed to be of that ſpecies: its texture is ſomewhat particular, being full of little ſhining veins or threads like needles, brittle as glaſs. Sometimes there are veins of a red or golden colour intermixed, which is called *male antimony*, that without them being denominated *female*. It fuſes in the fire, though with ſome difficulty, and diſſolves more eaſily in water.

When dug out of the earth it is put into large crucibles, fuſed by a violent fire, and then poured into cones, the apex whereof is always the beſt and

pureſt part, as the baſis or broadeſt part is the fouleſt.

The uſes of *antimony* are very numerous and important.—It is a common ingredient in ſpecula, or burning concaves, ſerving to give them a finer poliſh. It makes a part in bell-metal, and renders the ſound more clear. It is mingled with tin to make it more hard, white and ſounding, and with lead in the caſting of printers letters, to render them more ſmooth and firm. It is a general help in the melting of metals, and eſpecially in the caſting of cannon balls.

Cinnabar is a mineral ſtone, red, heavy, and brilliant, found chiefly in the quickſilver mines.

Cinnabar is either *native* or *factitious*.

Native, or *mineral cinnabar*, which is that abovementioned, is found in moſt places where there are quickſilver mines; yet it has mines of its own.

It may be eſteemed as marcaſite of quickſilver, or rather as quickſilver petrified and fixed, by means of ſulphur, and a ſubterraneous heat; for the globulous particles of quickſilver being put into a natural motion, by the ſubterraneous heat roll themſelves in the ſulphur, already ſoftened by the ſame heat, wherein being wrapped, at laſt their whole motion is intercepted; and the whole compoſition being hardened afterwards by the ſame graduate heat, becomes that red, heavy, and brilliant ſtone, we call *native cinnabar*.

Each pound of good *cinnabar* yields fourteen ounces of good mercury.

The beſt *mineral cinnabar* is of a high colour, brilliant, and free from the ſtone. It is uſed by Phyſicians in venereal caſes, and others occaſioned by ſharp ſeroſities: it is alſo eſteemed a good cephalick, accounted of ſervice in epilepſies, and other nervous diſtempers; add, that it is reckoned of efficacy in cutaneous caſes, as the ſcurvy.

Factitious, or *artificial cinnabar*, is formed of a mixture of mercury and ſulphur ſublimed, and thus reduced into a kind of fine red glebe. The beſt is of a high colour, full of fibres like needles.

The *factitious cinnabar* is prepared, by melting one part of ſulphur in a pipkin; then putting to it by a little at a time, three parts of quickſilver, ſtirring them together till no mercury appears: then letting them cool, they grind the mixture, put it in a bolt-head, bake it, and place it over a naked fire, which they augment by degrees, a coloured fume ariſes firſt to the top of the ſubliming veſſel, which in the further progreſs of the heat, becomes at length of a red crimſon blue; taking it off the fire, the *cinnabar* is found above the fæces.

This ſerves for the ſame medicinal purpoſes with the *native cinnabar*; beſides which, it is likewiſe uſed by the farriers, to make pills for their horſes, and by painters as a colour; as being a very vivid red, but drying with ſome difficulty.

The *cinnabar*, called alſo by the painters *vermillion*, is rendered more beautiful by grinding it with gum-water, and a little ſaffron, thoſe two drugs preventing its growing black.

There is likewiſe a blue *cinnabar*, made by mixing two parts of ſulphur with three of quickſilver, and one of ſal ammoniack; thoſe being ſublimed produce a beautiful blue ſubſtance, whereas quickſilver and ſulphur alone produce a red.

Bismuth is a mineral body, half metallick, compoſed of the firſt matter of tin, while yet imperfect; and found uſually in tin mines, ſometimes alſo in ſilver mines.

Its ſubſtance is hard, ponderous, and brittle, of a large grain, gloſſy, white, and ſhining. It is alſo called *tin-glaſs*, becauſe when broke it ſhews a vaſt number of little poliſhed laminæ like glaſs: it is alſo called *marcaſite*, by way of excellence, becauſe ſurpaſſing all others in whiteneſs and beauty.

Biſmuth contains an arſenical ſalt, very dangerous to take inwardly.

Calamine ſtone, or *lapis calaminaris*, is a kind of foſſil, bituminous earth, of ſome uſe in medicine, but of more in foundry; being uſed to dye copper yellow, *i. e.* to convert it into braſs. It is either of a browniſh colour, as that of *Germany* and *England*; or reddiſh, as that about *Liege*, and in ſome parts of *France*, accounted the beſt, becauſe turning yellow by calcination.

When dug it is waſhed, or buddled, as they call it, in running water, which carries off the impure and earthy parts, leaving the lead, calamine, and other ſparry parts at bottom; they then put it in a ſieve, and ſhaking it well in water, the lead mixed with it ſinks to the bottom, the ſparry parts get to the top, and the *calamine* lies in the middle: thus prepared they bake it in an oven four or five hours, the flame being ſo contrived as to paſs over, and ſo to heat and bake the calamine, ſtirring and turning it all the while with iron rakes: this done, they beat it to powder and ſift it, picking out of it what ſtones they find; and thus it is fit for uſe.

Vitriol is a mineral ſubſtance, compoſed of an acid ſalt, intermixed with ſomething metalline.

It is defined by *Boerhaave* a ſaline, metallick, tranſparent glebe, diſſoluble in water, and fuſible and calcinable by fire.

It acquires different names, according to the different places where it is dug, and the *vitriols* of thoſe alſo, differ from each other in denomination and colour, ſome being white, others blue, and others green.

Roman and *Cyprus* vitriol, for inſtance, is blue; and that of *Sweden* and *Germany* greeniſh; beſides which there is alſo a white kind.

White vitriol partakes but little of any metal; *blue* partakes of copper, and *green* of iron.

According to *Boerhaave*, *vitriols* conſiſt of a metallick part, with a ſulphur adhering, a menſtruous acid, and water. In *blue vitriol*, the metal wherewith the acid, *&c.* is joined, is copper. In *white vitriol*, called alſo *white copperas*, it is mixed with lapis calaminaris, or ſome ferruginous earth, intermixed with lead or tin. In *green vitriol* the acid is joined with iron.

Roman vitriol is made by expoſing the pyrites to the air, till ſuch time as they calcine, and change into a greeniſh, and vitriolick calx or duſt; in which ſtate they are thrown into the water, and afterwards, by boiling and evaporation, reduced into that kind of cryſtals ſent us from *Italy*.

All other *vitriols* are made after the ſame manner; that is much after the ſame manner as allum is made in *England*, or ſaltpetre in *France*.

For green vitriol, they add a great number of pieces of iron to the liquor in the boiling; theſe raiſe a great ebullition. As ſoon as the iron is diſſolved they evaporate the diſſolution to a certain degree, and ſo let it cryſtallize. The cryſtals being furniſhed, there remains a thick, reddiſh, unctuous ſtyptick and aſtringent liquor.

The powder of this *vitriol* is exceedingly ſtyptick, and excellent for the cure of wounds, and the ſtopping of blood. It is this that makes the baſis of the famous ſympathetick powder.

PYRITES, from the *Greek* πυρ, q. d. fireſtone, is a ſulphureous inflammable kind of *mineral*, compoſed of an acid ſalt, incorporated with an oily or bituminous matter.

Pyrites bears an affinity to *marcaſite*, with which the generality of authors confound it.

Pyrites has always a metalline part in it, and ſometimes a cretaceous or okerous part.—In proportion as any of theſe prevails, the body commences a ſulphur, allum, or vitriol.

The metal in *pyrites* is chiefly iron; ſometimes there is copper in it, and always a little gold, rarely ſilver, and never lead or tin.

Dr *Liſter* attributes thunder, earthquakes, *&c.* to the ſulphureous and inflammable breadth of the *pyrites*.

MARCASITE is a ſort of metallick mineral, making as it were the ſeed or firſt matter of metals.

On this principle there ſhould be as many different *marcaſites* as metals; which is true in effect; the name being applied to every mineral body, that has metalline particles in its compoſition, though not enough to make it worth working, in which caſe it would be called ore.

There are only three kinds in the ſhops, *viz.* *Marcaſite* of gold, which is in little balls or nodules, about the bigneſs of nuts, nearly round, heavy, of a brown colour without.——*Marcaſite* of ſilver, which is like that of gold, only paler coloured within, the colour differs much, the one having a gold colour, and the other a ſilver colour, both ſhining and brilliant.——The *marcaſite* of copper, which is about the bigneſs of a ſmall apple, round or oblong, brown without, yellow and cryſtalline within, brilliant and ſhining.

Marcaſites are found in mines of metals; they all contain ſulphur and a vitriolick ſalt, eſpecially that of copper: ſome of them alſo contain antimony and biſmuth.

COBALT is a kind of marcaſite, ſuppoſed to be the *Cadmia* of the antients, out of which is drawn arſenick and ſmalt.

Cobalt uſually contains a little ſilver, ſome copper, but much arſenick. There are various mines of *cobalt*, eſpecially in *Saxony*, ſome in *France*, and *England*.

OKER, or OCHER, a yellow, dry, foſſil earth; harſh to the touch; found in copper and lead mines, ſometimes in thoſe of ſilver, and ſometimes in mines of its own.

Oker is always impregnated with iron, and is what generally gives to the chalybeate ſprings their medicinal virtues. Its chief uſe is in painting.

Only the yellow *oker* is natural; the red is prepared from the yellow, by calcining it in the fire, till it has acquired its redneſs.

The beds are uſually from one hundred and fifty, to two hundred feet deep; and their thickneſs from four to eight inches, between a white ſand which covers them a-top, and a yellow argillous earth underneath.

LAPIS HÆMATITES, called alſo *blood-ſtone*, is a kind of ruddy mineral in a form of a ſtone; thus called, either on account of its reſembling dry, curdled blood, or of the faculty it has of ſtanching of blood.

The native or foſſil kind comes from *Egypt*, *Bohemia*, &c. It has divers uſes in medicine; being held cooling and aſtringent, and in that quality preſcribed in hæmorrhages. It is given in ſubſtance, in form of a fine powder.

The gilders uſe it for burniſhers, to poliſh their gold withal.

The

The Armenian Stone, *lapis Armenus*, is a mineral ſtone or earth, of a blue colour, ſpotted with green, black, and yellow; antiently brought only from *Armenia*, but now found in *Germany*, and *Tyrol*.

The *Armenian ſtone* bears a near reſemblance to *lapis lazuli*, from which it ſeems only to differ in degree of maturity: they are diſtinguiſhed by this, that the *lapis Armenus* is ſofter, and inſtead of ſparks of gold, is ſpeckled with green.

Boerhaave ranks it among ſemi-metals; and ſuppoſes it compoſed of metal and earth. *Woodward* ſays it owes its colour to an admixture of copper.

Its chief uſe is in Moſaick work, though it has ſome place alſo in Phyſick.

Beſides the above-mentioned *minerals* or *foſſils*, there are others, as all kinds of *bitumen*, which in a general ſenſe, is a fatty, tenacious, mineral juice, very inflammable; or a foſſil body, which readily takes fire, yields an oil, and is ſoluble in water.

Naturaliſts diſtinguiſh three kinds of *bitumens*, *hard*, *ſoft*, *liquid*, or *oily*; each of which they ſubdivide into ſeveral others.

Among the *hard bitumens* are ranked *yellow amber*, ſometimes *amber-greaſe*, *jet*, *aſphaltum* or *Jews-pitch*, *piſſaſphaltum*, *pit-coal*, *black ſtone*, and *ſulphurs*.

Yellow Amber, *ſuccinum*, or *karabe*, is a yellow tranſparent ſubſtance, of a bituminous form or conſiſtence, but a reſinous taſte, or ſmell like oil of turpentine; chiefly found in the *Baltick ſea*, and along the coaſts of *Pruſſia*, &c.

Naturaliſts are infinitely divided as to the origin of *amber*: ſome referring it to the vegetable, others to the mineral, and ſome even to the animal kingdom.

The moſt remarkable property of *amber* is, that when rubbed, it draws or attracts other bodies to it. See the treatiſe of *Chymiſtry*.

Jet, *gagates*, called alſo *black amber*, is a light, ſmooth, pitchy, foſſil ſtone, extremely black; formed of a bituminous juice in the earth, in the manner of coal.

It works like amber, and has moſt of its qualities: it readily catches fire, flaſhes, and yields a bituminous ſmell.

Aſphaltum, or Aſphaltos, is a ſolid, brittle, black, inflammable, bituminous ſubſtance, reſembling pitch, brought from the eaſt, and particularly *Judea*; whence it is alſo called *Jews-pitch*.

The *aſphaltos* of the *Greeks*, is the bitumen of the *Latins*. It is chiefly found ſwimming on the ſurface of the *Lacus Aſphaltites*, or Dead-ſea, where antiently ſtood the cities of *Sodom* and *Gomorrah*. It is caſt up from time to time, in the nature of a liquid pitch, from the earth, which lies under this ſea; and being thrown upon the water, ſwims like other fat bodies, and condenſes by little and little, through the heat of the ſun, and the ſalt that is in it: it burns with great vehemence; in which it reſembles *Naphtha*; but is thicker, as to conſiſtence.

The *Arabs* uſe it to pitch their ſhips withal, as we do common pitch. There was a deal of it employed in the embalming of the antients.

It is ſuppoſed to fortify, and reſiſt putrefaction; reſolve, attenuate, cleanſe, and cicatrize wounds: but is little uſed among us, either externally or internally.

Piss-asphaltum denotes a native, ſolid bitumen; found in the *Ceraunian* mountains of *Apallonia*; of an intermediate nature between pitch and aſphaltum.

Pit-coal is ranked among the number of minerals, and the places it is dug out of are called *coal-mines*, or *coal-pits*.—The *Engliſh* coal is of moſt repute, even in foreign countries.

The goodneſs of coal conſiſts in its being as free as poſſible from ſulphur, in its heating iron well, and in its burning a long time in the ſmith's forge.

The ſtrata, or veins of coals in coal-pits, are numerous, and their order, quality, &c. different in different places.

In thoſe at *Dudley*, in *Staffordſhire*, the ſtrata below the turf, two or three clays, a grey ſtone, and a hard grey rock, are expreſſed in the *Philoſophical Tranſactions*, to be, 1. *Coal*, called *bench-coal*. 2. *Slipper-coal*, leſs black and ſhining than the former. 3. *Spin-coal*, more black and ſhining. 4. *Stone coal*, much like *canal coal*.

Theſe ſtrata's have between each of them a bat, or bed, of a peculiar ſort of matter, about the thickneſs of a crown-piece. Below theſe are divers metalline ſtrata's, as a black ſubſtance, call'd *dun-row-bat*; a grey iron ore, called the *dun-row iron-ſtone*; a bluiſh bat, called *white-row*; a blackiſh iron ore, called *white-row grains*, or *iron-ſtone*; a dark grey iron ore, called *bubble iron-ſtone*; laſtly, the *table bat*.

Then, 5. Comes a coarſe ſort of *coal*, called *foot coal*; a black brittle bat. 6. The *heathen-coal*. 7. A ſubſtance like coarſe *coal*, though called a *bat*, becauſe it does not burn well. And, 8. *Bench coal*.

Black-

BLACK-STONE, or BLACK-LEAD, is a kind of mineral ſtone, of a black colour, but ſilver'd, and ſhining, found chiefly in lead-mines, and appearing to be nothing elſe but lead, nor yet arrived at maturity; much uſed for pencils, or crayons for deſigning. It is melted like the common lead.

SULPHUR is a fat, unctuous ſort of mineral ſubſtance, fuſible, and inflammable by fire. See *Chymiſtry*.

Soft BITUMENS, are the *maltha*, *bitumen* of *Calco*, of *Surinam*, and *Copal*. The *naphtha* of *Italy*, *Petroleum*, and *Zacinthius*.

The MALTHA is a kind of bitumen, wherewith the *Aſiaticks* plaiſter'd their walls. When this is once ſet on fire, water will not quench it, but ſerves rather to make it burn more fiercely.

The NAPHTHA is a kind of liquid bitumen, very oily and inflammable, exuding out of the earth, or ſwimming on the ſurface of the water of ſome ſprings. It is uſually of a black colour; though that found in certain ſprings about *Babylon*, is ſaid to be whitiſh.

That of *France* is ſoft and black, like liquid pitch, and of a fætid ſmell; that of *Italy* is a kind of *petrol*, or a clear oil, of various colours, oozing out of a rock, ſituated on a mountain, in the dutchy of *Modena*.

The *naphtha* is eſteemed penetrating, reſolutive, and vulnerary; but its virtues are little known in medicine. Its chief uſe is in lamps, *&c.* on account of its inflammability.

PETROL, PETROLEUM, q. d. *petræ oleum*, rock-oil, is an oleaginous juice, ſuppoſed to iſſue out of the clefts of rocks; and found floating on the water of certain ſprings.

Olearius ſays, he ſaw above 30 ſprings near *Scamachia* in *Perſia*: there are alſo *petrols* in the ſouthern provinces of *France*; but the beſt are thoſe in the dutchy of *Modena*, firſt diſcovered by *Arioſto*, a Phyſician, in 1640, in a very barren valley, twelve leagues from the city of *Modena*.

From a mixture of oleaginous, and ſaline juices with the earth, ariſe ſeveral concretions, as *ſand*, *argilla*, *bole*, *ſtone*, *flint*, &c. and each of them is a kind of *foſſil*.

SAND is a fine, hard, gravelly ſort of earth, or rather ſtones, divided into ſmall grains.

Sand is formed of a perfect diſſolution of a ſmall portion of earth, made by ſaline juices, which have formed themſelves with that earth, into little globules, which men have been pleaſed to call *ſand*, which having been liquid in its formation, or perforated on all ſides, by the particles of light, retain ſtill, after it is harden'd, the ſame faculty of tranſmitting light.

The production of ARGILLA (which is a white dry earth, like chalk, but more friable) is almoſt the ſame with that of ſand; unleſs that *argilla* being compoſed of much ſmaller grains, ſeems to contain more oleaginous juice than ſand.

Biſhop *Wilkins* divides *ſtones* into *vulgar*, *middle price*, and *precious*.

Vulgar STONES, or ſuch as are of little price, are diſtinguiſhable by their different magnitudes, uſes, and conſiſtence, into the

- Greater magnitudes of *ſtone* uſed either about
  - Buildings, whether of
    - Walls; chiefly being of a
      - Softer conſiſtence, whether natural or factitious,
        1. *Free-ſtone*, *Brick*.
      - Harder conſiſtence; not eaſily yielding to the tool of the workman, growing either in
        - Great maſſes,
          2. *Raggs*.
        - Leſſer maſſes; whether ſuch as are for their figure,
          - More knobbed, and unequal, uſed for ſtriking of fire, either the more common, which is leſs heavy; or leſs common, which is more heavy; as having ſomething in it of a metalline mixture.
            3. *Flint*, *Marcaſite*. *Fire-ſtone*.
          - More round and even,
            4. *Pebble*, thunderbolt.
    - Roof, or pavement, being of a luminated figure, either natural or factitious.
      5. *Slate*, *Tyle*.
  - Metals, either for the
    - Sharpening or trying of them,
      6. *Whet-ſtone*, *Touch-ſtone*.
    - Poliſhing, or cutting them; being either of a more ſpungy and ſoft, or of a more hard conſiſtence.
      7. *Pumice*, *Emery*.
- Leſſer magnitudes, either more, leſs, or minute.
  8. *Sand*, *Gravel*.

2. *Middle*

2. *Middle priced* Stones, are either of a

Shining poliure, or capable of it; whether of a

ſimple white colour, and more ſoft conſiſtence,

1. *Alabaſter.*

Sometimes white, ſometimes black. or green, and ſometimes variegated with veins, growing in greater or leſs maſſes,

2. *Marble, porphyry, Agat.*

Spotted with red, upon a greeniſh colour, or with ſpots of gold colour upon blue,

3. *Jaſpis, heliotryx, Lazuli, azure ſtone.*

Tranſparency, either

brittle; whether natural or factitious,

4. *Cryſtal, Glaſs,*

Fiſſilk into flakes, either greater or leſſer,

5. *Scletine*, Muſcovia *glaſs*, *isinglaſs*, *Talc.* *ſpar*,

Relation to metals, attracting iron, or making of braſs.

6. *Load-ſtone, Cadmia, calaminaris.*

Incombuſtible nature,

7. *Amiantus, aſbeſtus.*

Strange original; not being properly minerals, tho' uſually reckoned among them; but either a ſubmarine plant, or ſuppoſed to proceed from a liquid bitumen,

8. *Coral, coralline, Amber.*

Precious Stones he ſubdivides into *more* and *leſs tranſparent.*

The *leſs tranſparent* he diſtinguiſhes by their colours, into red, as the *ſardian* and *cornelian*; pale, fleſhy colours, like that of a man's nail, as the *onyx*; bluiſh, as the *turquois*: pale purple, as the *chalcedony*; and thoſe of various colours, as *opal*, and *cat's eye.*

The *more tranſparent* he diſtinguiſhes into ſuch as are colourleſs, as the *diamond* and *white ſapphire*; and coloured, which are either red, as the *ruby*, *carbuncle*, and *granate*; yellow, as the *chryſolite* and *topaz*; green, as the *emerald*, *ſmaragd*, and *beryl*; bluiſh, as the *ſapphire*; and purple or violaceous, as the *amethyſt* and *hyacinth.*

Earth, as we take it in this place, is alſo a foſſil or terreſtrial matter, whereof our globe principally conſiſts; whoſe character is to be neither diſſoluble by fire, water, nor air; nor tranſparent, more fuſible than ſtone, and generally containing ſome degree of fatneſs.

Of ſuch *earths*, ſome are ſimple and immutable; others compound and fatty. Of the firſt kind is *chalk*, *pumice*, and *rotten-ſtone.* Of the ſecond or compound kind, are *boles* of all kinds, red, white, and brown; *fuller's earth*, the divers kinds of medicinal earth, as the *Cretica*, *Hungarica*, *Turcia*, *ſuecia*, *Lemnian earth*, *Malta earth*, *terra ſigillata.*

With regard to the *ſimple earths.* Chalk, is a white foſſil ſubſtance, uſually reckoned as a ſtone; but Dr. *Slare* thinks, without reaſon; ſince when examined by the hydroſtatical ballance, it is found to want much of the weight and conſiſtence of a real ſtone: ſo that he thinks it more juſtly ranked among the earths.

Pumice, reckoned by a great number of Naturaliſts, as a kind of ſpongeous ſtone, very porous and friable; is by others conſidered as a kind of earth: neither are they agreed about the nature and origin of *pumice.* Some look on it as pieces of rock half-burnt and calcined, caſt up in eruptions of vulcano's, particularly *Ætna* and *Veſuvius*, into the ſea; and which being there waſhed in the ſalt-water, lays aſide the black colour, that the impreſſion of the ſubterranean fires had given it, and becomes whitiſh, or ſometimes only greyiſh, according as it has floated more or leſs in the ſea.

Dr. *Woodward* conſiders *pumice*, as only a ſort of ſlag, or cinder; and affirms, it is only found either where forges of metals have antiently been, or near ſome vulcano or burning mountain.

Other authors will have the *pumice* to riſe from the bottom of the ſea; whence they ſuppoſe it detached by ſubterraneous fires. And hence account both for its lightneſs and poroſity, and its ſaline taſte: alledging, in confirmation hereof, that *pumice* is frequently found in parts of the ſea far remote from all vulcano's; and adding, that ſeveral parts of the *Archipelago* are frequently found cover'd with it, all at once, after a few inward ſhakes and heavings of the bottom of the ſea.

Pumice makes a very conſiderable article in commerce, and is much uſed in the arts and manufactures, to poliſh and ſmooth ſeveral works.

Its pieces are of ſeveral ſizes: the parchment-makers and marblers uſe the largeſt and lighteſt. The Curriers the heavieſt and flatteſt. The Pewterers the ſmalleſt.

Pliny obſerves, that the antients made conſiderable uſe of *pumice*, in medicine; but it is out of the preſent practice.

As to the ſecond, or *compound kind of earths.* Boles abound with ſalts of different forms or figures. For the ſpirit of vitriol, which is an acid, poured upon the *Armenian bole*, cauſes no ebullition; but if it be poured upon the *terra ſigillata*, or *Lemnian bole*, it will excite a very great effer-

veſcence,

veſcence, or ebullition; which denotes a very great variety of ſalts in thoſe earths, or boles.

The *Armenian* BOLE, popularly, though corruptly called in *Engliſh*, *bole ammoniack*, is a ſoft, friable, fatty earth, of a pale red colour; eaſily pulverized, and which adheres to the tongue; eſteemed a good dryer, ſtyptick, and vulnerary; and in theſe qualities uſed in divers diſeaſes, both internally and externally.

This *bole* is eaſily falſified; and the Druggiſts frequently ſell *Lemnian*, or other earth in lieu thereof. *Matthoilus* ſays, it is found in gold, ſilver, and copper-mines.

BOLE *of the Levant*, is a medicinal earth brought from the *Levant*; nearly of the ſame nature, and having the ſame uſes with the *Armenian bole*.

FULLERS-EARTH is a fatty, foſſil earth, abounding in nitre; of great uſe in the woollen manufacture; and I believe peculiar to *England*, where its exportation is prohibited.

Terra ſigillata is a kind of earth or bole, dug in the Iſle of *Lemnos*, and thence alſo called *Lemnian* earth, of conſiderable uſe in Painting and Medicine.

It is of different colours, but moſt commonly red; heavy, ſoft, and friable; held very aſtringent, and as ſuch uſed in hæmorrhages; as alſo againſt the plague and poiſon. *Pliny* attributes to it ſeveral other virtues. It is an ingredient in Venice-treacle.

It was antiently found in a mountain, in the neighbourhood of the city *Hephæſtia*; where *Diana*'s prieſts went at certain times with great ceremony to dig it up. After a little preparation they made it up in *troches*, and ſealed them with *Diana*'s ſeal; whence the appellation of *ſigillata*, *ſealed*.

It is now brought from *Conſtantinople* in little flat cakes, round on one ſide, flat and ſealed on the other.

MINERAL-WATERS, are thoſe, which at their ſpringing forth from under ground, are found impregnated with ſome *mineral* matter, as ſalt, ſulphur, vitriol, &c. and the divers mixtures made in them of ſeveral of thoſe matters together, conſtitute ſo many different kinds of *mineral-waters*.

The waters of the ſame ſprings, can, in divers times, receive notable alterations or changes, by new mixtures, or by thoſe which have been made being entirely exhauſted.

To diſcover the nature and qualities of *mineral-waters*, the following method is to be obſerved.

1. From what place they are.—2. In what time, or diſpoſition of the air they have been taken in their ſprings.—3. If they are ſent in bottles to the phyſician who is to examine them, he muſt enquire how long they have been in bottles, and if the bottles were clean, and have been well corked.—4. If they have made ſome ſediment in the bottles, and of what kind.—5. If thoſe waters are limpid or muddy.—6. If they have ſome ſmell and ſome manifeſt flavour.—7. If their weight differs notably from that of ſimple and common water.—8. If they change colour by being mixed with galls, or oak-leaves, or pomegranate's peel, myrabolans, &c.—9. If having been expoſed to the air, or a little heated, they are no longer ſuſceptible of colour.—10. If being put in diſtillation through the alembick, in balneo-mariæ, there ariſes and diſtils firſt ſome liquor more ſubtile than the reſt, and if there be found ſome differences between the diverſe portions of the ſame water diſtilled, received ſeparately.—11. If in the evaporation or diſtillation of thoſe waters, at a very moderate heat, ſome pellicles be formed on the ſurface of the water; or if ſome terreſtrial concretions be made floating by flakes in the water, or adhering to the ſides of the veſſels, or ſettling at the bottom, and which.—12. If after an almoſt total diſtillation or evaporation of thoſe waters, ſome ſaline, fibrous, granulated, or otherwiſe figurated concretion, be made in the liquor left, and expoſed in a cold place.—13. If the water being all evaporated, or diſtilled dry, leaves a ſettling, how much, and what ſort of ſettling.—14. If the terreſtrial ſettling contains ſome portion of ſalt or not.—15. To which ſalts, of thoſe commonly known, the ſalts of thoſe waters can have a report.—16. If they precipitate into a red, or yellow colour ſublimate mercury diſſolved in common water; and if they precipitate likewiſe, the ſulphureous earths of common vitriol, as do the true nitre of the antients, the natron of *Egypt*, the white lode, and the foſſil borax.—17. If they change green the colour of ſyrup of violets, and if they reſtore the blue colour of the tourneſol, turned red by ſome alluminous vitriolick acid or other, as the true nitres do.—18. If they turn red the tourneſol, as the allum and vitriol do.—19. If they thicken and coagulate quickly, the liquor of the fixed ſalt of tartar, as does the ſucculent and ſecond portion of common ſalt, which is not condenſed but by a total evaporation of the water in which that ſalt has been diſſolved.—20. If they cauſe no changes in the waters of the diſſolutions of ſublimate mercury and vitriol, nor on the ſyrup of violet, nor on the liquor of the ſalt of tartar reſolved, no more than do ſaltpetre, and the firſt portion of common ſalt, which is cryſtallized when

expoſed in a cold or damp place.—21. If the earthy ſettlings of thoſe waters, after the ſeparation of their ſalts, are entirely, or in part diſſoluble in diſtilled vinegar, and with ſome ebullition, as certain ſorts of chalks, as does the white earth of the curds of nitrous and alkali ſalts, produced by the mixture of the ſecond portion of common ſalt.—22. If thoſe terreſtrial ſettlings diveſted of ſalts, put to the fire and ſtrongly heated in *German* crucibles, be fixed if they change colour, if they are vitrified or calcined, and if by means of the reductive ſalts, ſomething metallick can be extracted from it or not.—23. And if their ſalts purified, after they have been melted at the fire in crucibles of a good vitrified earth, aſſume ſome extraordinary colour.

All *mineral-waters* are either hot, or luke-warm, or cold; they alſo differ in the taſte, for ſome of them are ſour or vinous, ſome auſter or ferruginous, and others without any manifeſt flavour, or inſipid.

All thoſe ſenſible differences, joined to thoſe which are the moſt remarkable in the ſettling of thoſe waters, after diſtillation or evaporation, and particularly in the participation of certain ſalts, ſome of which have ſome report to common ſalt, and others to the nitre of the antients, have given occaſion to diſtribute *mineral-waters* into ſeveral claſſes, to diſpoſe in ſome order the hiſtorical detail of the obſervations made in examining them.

In the firſt of theſe claſſes are the *hot waters*, in which is found a ſalt which has a report to common ſalt.

In the ſecond are the hot waters, whoſe ſalt is found like to the nitre of the antients.

In the third are the inſipid *luke warm waters*, which participate of ſome ſalt, either common or nitrous, and ſome which have no ſalt at all.

In the fourth, are the *luke-warm waters* of a ſouriſh or vinous taſte, which participate ſomething of the true nitre.

In the fifth, are the inſipid *cold waters*, which participate of ſome ſalt like to common ſalt, and ſome in whoſe analyſis no ſalt is found.

In the ſixth, are the *cold waters*, whoſe flavour is ferruginous or auſter.

In the ſeventh, are the *cold waters* of a ſouriſh or vinous taſte, which participate of common ſalt.

And in the eighth, are the *cold waters*, of a ſouriſh or vinous taſte likewiſe, which participate of the true nitre.

In the ſeveral experiments which have been made on *mineral waters*, none of the hot ones have been found ſouriſh, and none of the inſipid cold ones nitrous.

The chief hot mineral ſprings in *England*, are thoſe near *Wells* in *Somerſetſhire*, and thoſe others at *Buxton* and *Maltock* in *Derbyſhire*; which latter however, are rather warm or tepid than hot.

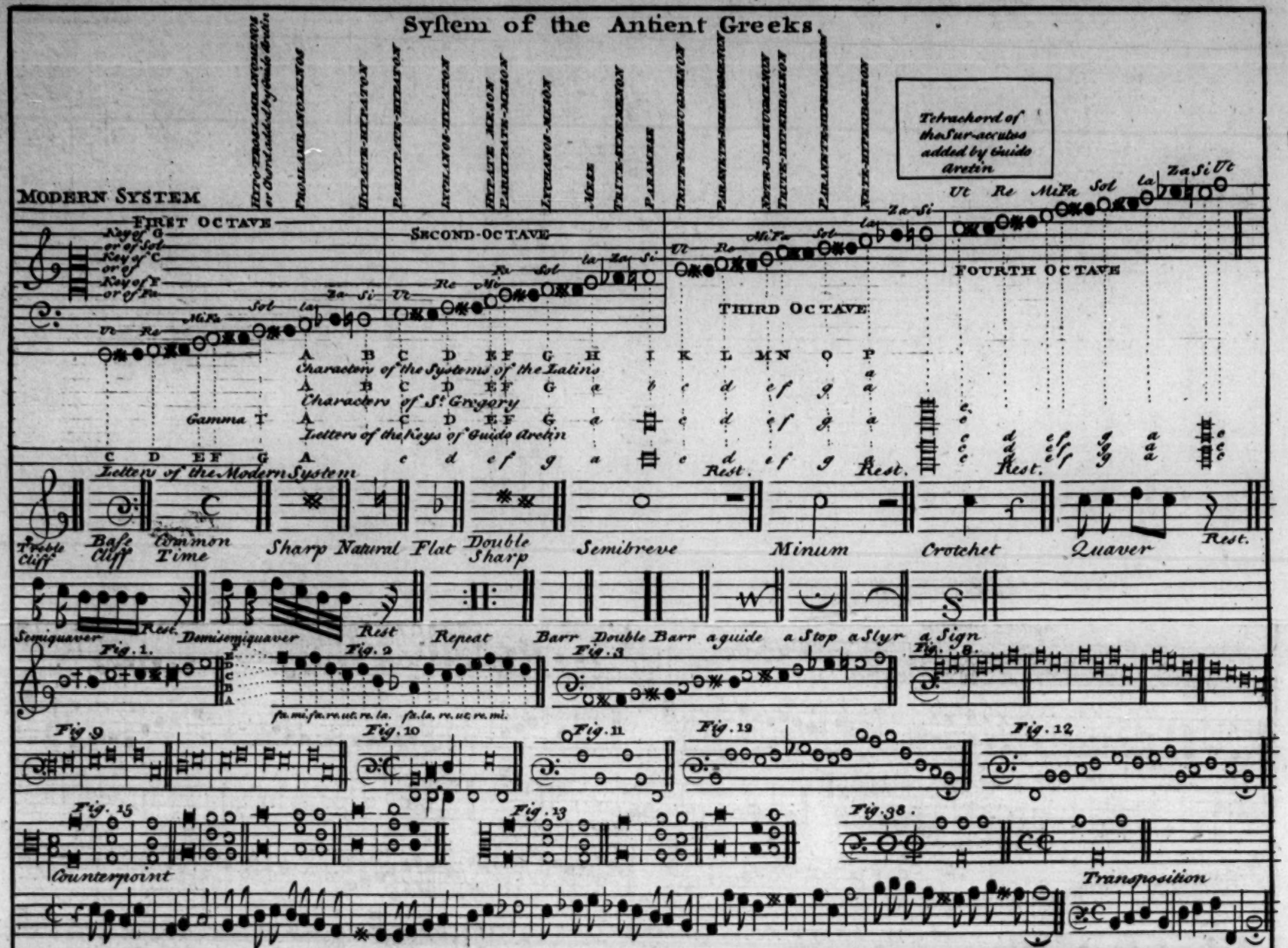
In the city of *Bath* are four hot baths; one triangular called the *croſs-bath*, from a croſs that formerly ſtood in the midſt of it; the heat of which is more gentle than the others, becauſe it has fewer ſprings. The ſecond is the *hot-bath*, which heretofore was much hotter than the reſt, when it was not ſo large as it now is. The other two are the king's and queen's baths, divided only by a wall; the laſt having no ſpring, but receiving the water from the king's bath, which is about ſixty feet ſquare, and has in the middle of it many hot ſprings, which render its healing quality more effectual. Each of theſe is furniſhed with a pump to throw out water upon the diſeaſed, where it is required.

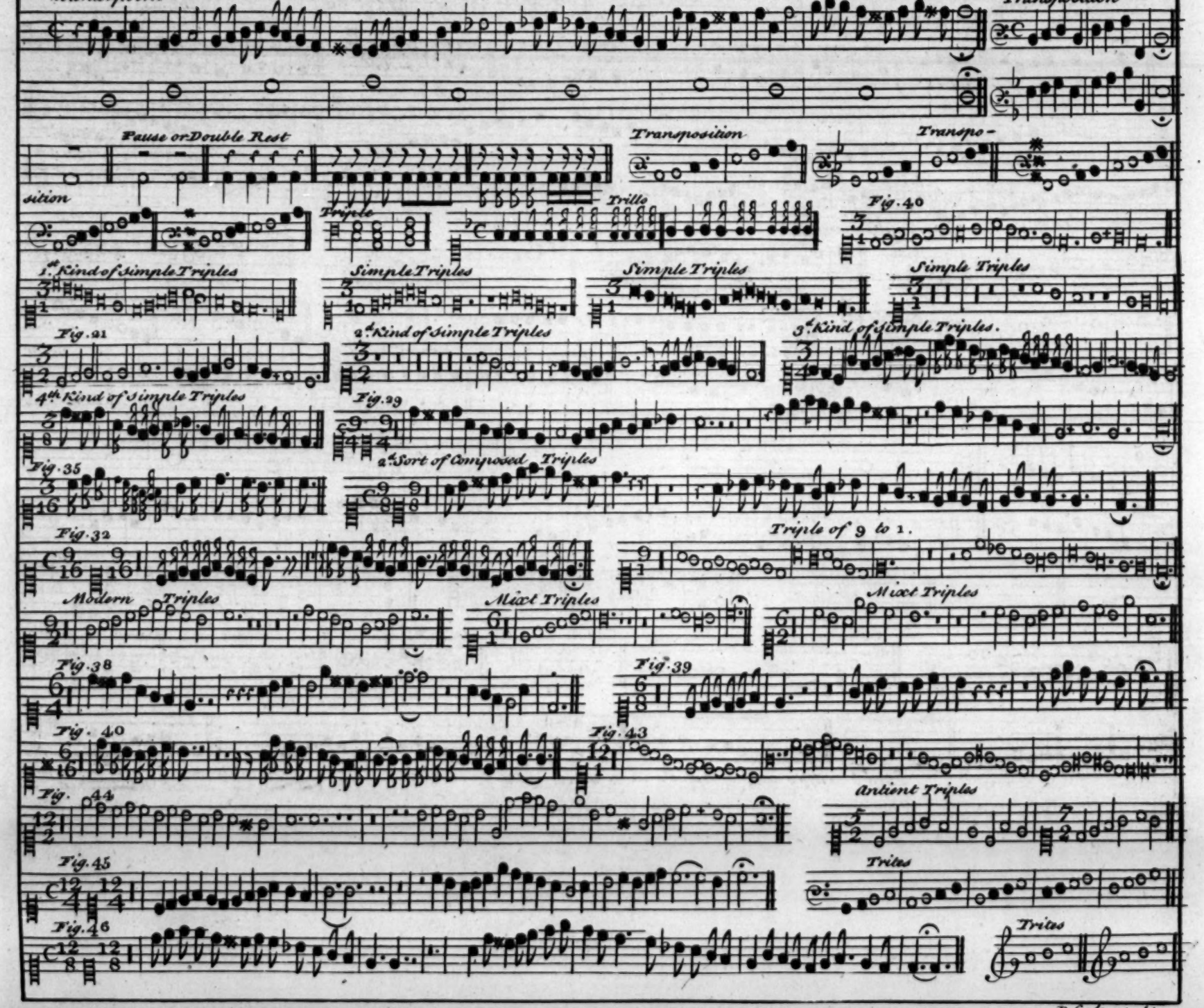
Theſe waters abound with a mineral ſulphur; they are hot, of a bluiſh colour, and ſtrong ſcent, and ſend forth thin vapours. They do not paſs through the body like moſt mineral waters, though if ſalt be added, they purge preſently. On ſettlement they afford a black mud, which is uſed by way of cataplaſm in aches, of more ſervice to ſome than the waters themſelves; the like they depoſite on diſtillation and no other.

Dr. *Aſtendoff* found the colour of the ſalt drawn from the king's and hot bath, yellow; and that from the *croſs-bath*, white; whence he concludes, that the *croſs-bath* has more allum and nitre than the hot, which, tho' it abounds more with ſulphur, I conclude hence that it is all nitre and no allum. The *croſs-bath* is ſuppoſed to prey on ſilver, and all of them on iron, and none on braſs.

The uſe of theſe baths is found beneficial in diſeaſes of the head, as palſies, *&c.* in cuticular diſeaſes, as leproſies, *&c.* obſtructions and conſtipations of the bowels, the ſcurvy and ſtone, and in moſt diſeaſes of women and children. The baths have performed many cures, and are commonly uſed as a laſt remedy in obſtinate chronick diſeaſes; where they ſucceed well, if they agree with the conſtitution of the patient.

A General Table of the Four Systems of Music




Pause or Double Rest
Transposition
Transpo-
sition
Triple
Trille
Fig. 40
1st. Kind of Simple Triples
Simple Triples
Simple Triples
Simple Triples
Fig. 21
2d. Kind of Simple Triples
3d. Kind of Simple Triples.
4th. Kind of Simple Triples
Fig. 29
Fig. 35
2d. Sort of Composed Triples
Fig. 32
Triple of 9 to 1.
Modern Triples
Mixt Triples
Mixt Triples
Fig. 38
Fig. 39
Fig. 40
Fig. 43
Fig. 44
Antient Triples
Fig. 45
Tritus
Fig. 46
Tritus
B. Cole sculp.

Gammut, or Guido's Scale.

		B dur	nat	molle
	cc	la	mi	
	dd	sol	re	la
	ee	fa	ut	sol
	ff	mi		
	gg	re	la	mi
G	aa	ut	sol	re
	bb		fa	ut
	c	la	mi	
	d	sol	re	la
	e	fa	ut	sol
	f	mi		fa
	g	re	la	mi
	a	ut	sol	re
	G		fa	ut
	F	la	mi	
	E	sol	re	
	D	fa	ut	
	C	mi		
	B	re		
	A	ut		
	F			

Fig. 15.

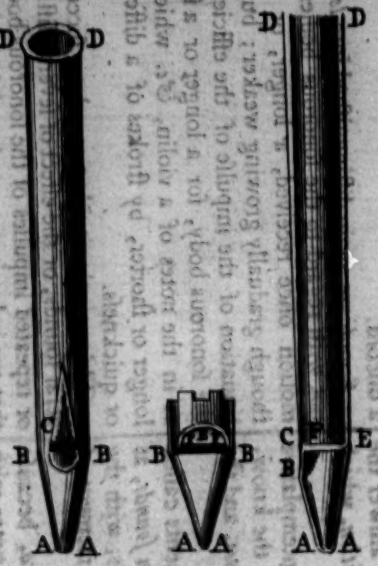
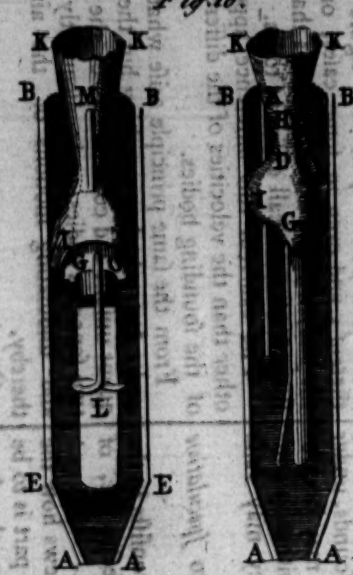


Fig. 16.

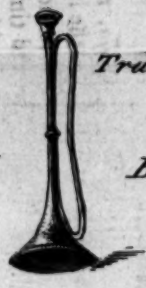


French Horn.

Baſsviole.

Harpsicord.

Trumpet.



Baſsviolin.

Violin.

Hautboy.

Common flute.

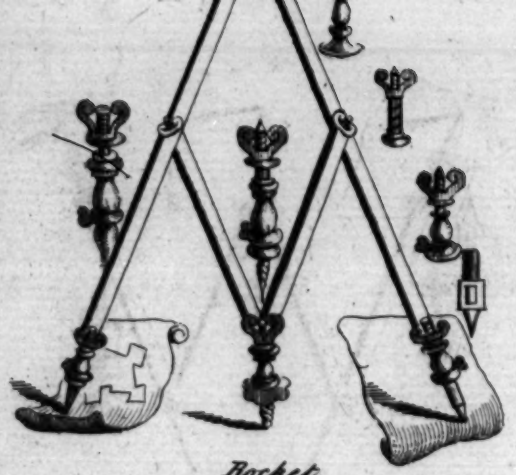
German flute.

Baſsoon.

Pentagraph

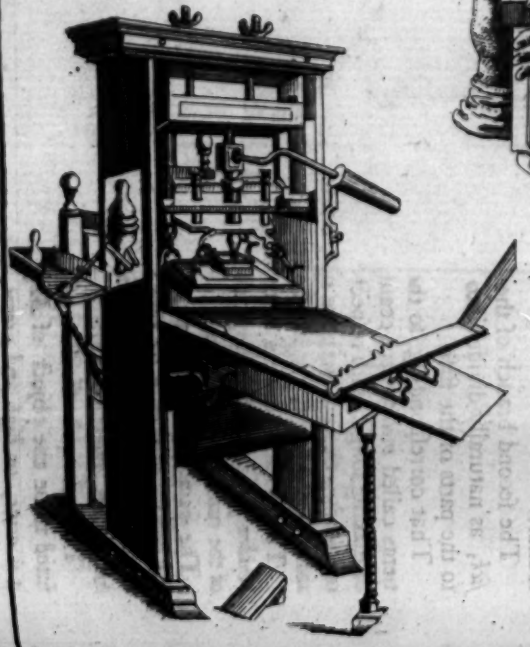
Rocket.

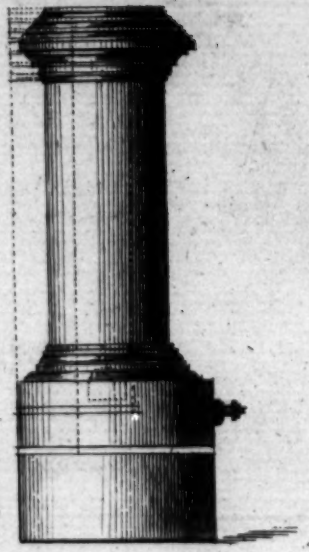
Rockets.



Rocket.

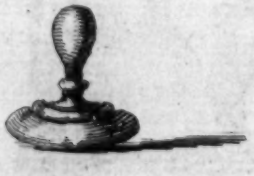
Printing Press.



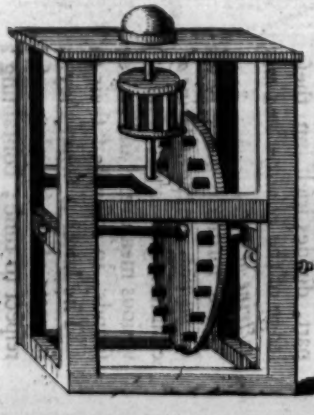


Composing Stick.

Grinding.



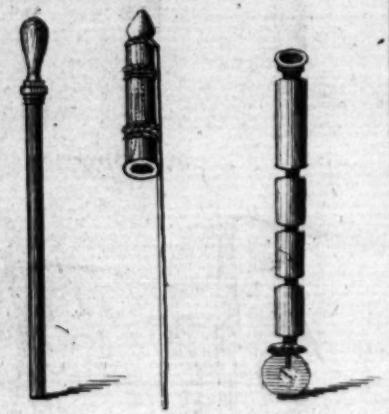
Grinding.



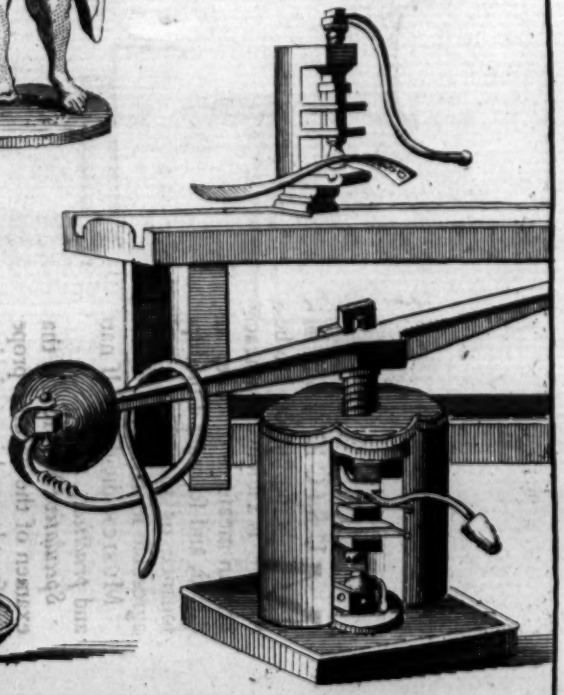
Grinding.

Sculpture.

Rockets.



Mill for Coining.



R. Cooke sculp.

MUSICK.

MUSICK (from *muſa*, muſe, the Muſes being ſuppoſed to be the inventors thereof) is a ſcience that teaches how ſounds, under certain meaſures of tune, and time, may be produced, and ſo order'd or diſpos'd, as either in conſonance or ſucceſſion, or both, they may raiſe agreeable ſenſations.

MUSICK divides itſelf naturally into *ſpeculative* and *practical*.

Speculative MUSICK is that which conſiſts in the examen of the nature, properties, effects, &c. of the ſounds, and in reaſoning on them.

Practical MUSICK is that which ſhews how the knowledge acquired by the ſpeculative part is to be applied; or how ſounds in the relations they bear to *Muſick*, may be order'd, variouſly put together, in ſucceſſion, and conſonance, ſo as to anſwer the end. And this we call *the art of compoſition*, which is properly the practical part of *Muſick*.

The firſt branch, which is the contemplative part, divides itſelf into theſe two, *viz.* the knowledge of the *relations and meaſures of tunes*, and the *doctrine of time*.

The former is properly what the antients called *harmonica*, or the *doctrine of harmony in ſounds*, as containing an explication of the grounds, with the various meaſures, and degrees of the agreement of ſounds, in reſpect of their tune.

The latter is what they call *rhythmica*, becauſe it treats of the numbers of ſounds, or notes with reſpect to time; containing an explication of long and ſhort, of ſwift and ſlow, in the ſucceſſion of ſounds.

The ſecond branch of the *practical part of Muſick*, as naturally divides into two parts, anſwering to the parts of the firſt.

That correſponding to the harmonica, the antients called *melopœia*, becauſe it contains the rules of making ſongs, with reſpect to time and harmony of ſounds; though we have no reaſon to think the antients had any thing like compoſition in parts.

That which anſwers to the rhythmica they call *rhythmopœia*, containing rules for the application of the numbers and time.

The *ſpeculative* or *theoretical Muſick*, has for object the *ſound*; which in *Muſick* denotes a quality, in the ſeveral agitations of the air, conſidered as their diſpoſition, meaſure, &c.

The principal affection of *ſound*, whereby it is fitted to be the object of *Muſick*, is that whereby it is *acute*, or *high* and *grave*, or *low*.

This difference depends on the nature of the ſonorous body; the particular figure and quantity thereof; and even in ſome caſes, on the part of the body where it is ſtruck, and is that which conſtitutes what we call different tones.

The cauſe of this difference appears to be no other than the velocities of the different vibrations of the ſounding bodies.

From the ſame principle ariſe what we call *concords*, &c. which are nothing but the reſult of frequent unions and coincidences of the vibrations of two ſonorous bodies, and conſequently of the waves and undulating motions of the air occaſioned thereby.

On the contrary, the reſult of leſs frequent coincidences of thoſe vibrations, is what we call a diſcord.

Sounds are again diſtinguiſhed into *long* and *ſhort*, not with regard to the ſonorous bodies retaining a motion once received, a longer, or a leſs time, though gradually growing weaker; but to the continuation of the impulſe of the efficient cauſe on the ſonorous body, for a longer or a ſhorter time, as in the notes of a violin, &c. which are made longer or ſhorter, by ſtrokes of a different length or quickneſs.

This continuity is properly a ſucceſſion of ſeveral ſounds, or the effect of ſeveral diſtinct ſtrokes, or repeated impulſes of the ſonorous body, ſo quick that we judge it one continued ſound; eſpecially if it be continued in the ſame degree of ſtrength: and hence ariſes the doctrine of *meaſure* and *time*.

Another diſtinction of *ſounds* is into *ſimple* and *compound*, and that two ways.

A *ſimple ſound* ſhould be the effect of a ſingle vibration, or of ſo many vibrations as are neceſſary to raiſe in us the idea of *ſound*. In the ſecond ſenſe of *compoſition*, a ſimple ſound is the product of one voice, or one inſtrument, &c.

A *compound ſound* conſiſts of the *ſounds* of ſeveral diſtinct voices, or inſtruments all united in the ſame individual time and meaſure of duration, that is, all ſtriking the ear together, whatever the other differences may be, but in this ſenſe again, there is a two fold compoſition, a natural and artificial one.

The natural compoſition is that proceeding from the manifold reflections of the firſt *ſound* from adjacent bodies, where the reflections are not ſo ſudden as to occaſion echo's, but are all in the ſame tune with the firſt note.

The artificial compoſition, which alone comes under the Muſician's province, is that mixture of ſeveral *ſounds*, which being made by art, the ingredient *ſounds* are ſeparable, and diſtinguiſhable from one another.

Sounds are diſtinguiſhed again into *ſmooth* and *even*, or *rough* and *harſh*, alſo *clear* and *hoarſe*.

Smooth and *rough ſounds* depend principally on the ſounding body; of this we have a notable inſtance of ſtrings that are uneven, and not of the ſame dimenſion or conſtitution throughout.

As to *clear* and *hoarſe ſounds*, they depend on circumſtances which are accidental to the ſonorous body; thus a voice or inſtrument will be hollow and hoarſe, if raiſed within an empty hogſhead; that yet is clear and bright out of it: the effect is owing to the mixture of other and different *ſounds* raiſed by reflection, which corrupt and change the ſpecies of the primitive *ſound*.

Harmonical ſounds are produced by the parts of chords, *&c.* which vibrate a certain number of times while the whole chord vibrates once. By this they are diſtinguiſhed from the third, fifth, *&c.* where the relations of the vibrations are four to five, or five to ſix, or two to three.

The relations of ſounds had only been conſidered in the ſeries of numbers, 1 : 2, 2 : 3, 3 : 4, 4 : 5, *&c.* which produced the intervals, called *octave*, *fifth*, *fourth*, *third*, &c. M. *Sauveur* firſt conſidered them in the natural ſeries 1, 2, 3, 4, *&c.* and examined the relations of the *ſounds* ariſing therefrom. The reſult is, that the firſt interval, 1 : 2, is an octave; the ſecond, 1 : 3, a twelfth; the third, 1 : 4, a fifteenth, or double octave; the fourth, 1 : 5, a ſeventeenth; the fifth, 1 : 6, a nineteenth, *&c.*

The difference between two ſounds, in reſpect of *acute* and *grave*, or that imaginary ſpace terminated by two ſounds, differing in acuteneſs or gravity, is called *interval*.

When two or more ſounds are compared in this relation, they are either equal or unequal in the degree of time: ſuch as are equal are called *uniſons*, with regard to each other, as having one tune; the other being at a diſtance from each other, conſtitute what we call an *interval* in *muſick*; which is properly the diſtance in tune between two ſounds.

Intervals are diſtinguiſhed into *ſimple* and *compound*.

Simple Interval is that without parts, or diviſion: ſuch are the *octave*, and all that are within it; as the *ſecond*, *third*, *fourth*, *fifth*, *ſixth* and *ſeventh* with their varieties.

Compound Interval conſiſts of ſeveral leſſer *intervals*; ſuch are all thoſe greater than the octave; as the *ninth*, *tenth*, *eleventh*, *twelfth*; which diſtinction of *intervals* is clearly ſeen, at one view, in the following table:

1	2	3	4	5	6	7	*Simple.*
8	9	10	11	12	13	14	*Double.*
15	16	17	18	19	20	21	*Triple.*
22	23	24	25	26	27	28	*Quadruple.*
29	&c.						

Intervals.

Thoſe of the upper rank mark the *ſimple intervals*; and the other three, the *compound* ones, *viz.* either *double*, as thoſe of the third rank; or *quadruple*, as thoſe of the fourth rank, *&c.*

To reduce at once a *compound* to a *ſimple interval*, there's nothing elſe to do, but to take 7 off the number which gives it the name; if nothing remains, the *ſeventh* will be the *ſimple interval*; if ſomething remains, the figure left will be the name of the *ſimple interval*. As for example, if one will know what is a *thirteenth*, he muſt take off 7 from the number 13, and there remains 6; a *thirteenth* therefore is properly a 6th doubled. Or if we want to know what is a *twenty-ſixth*, we muſt take off three times 7, or 21, and there remains 5, the 26th therefore is a fifth quadrupled. All *compound intervals* are always reputed of the ſame nature with the *ſimple*, which anſwer to it.

Of the twenty-nine *intervals* which compoſe our table, ſome are called by the *Italians*, *conſonanti*, conſonants; others *diſſonanti*, diſſonants.

The *conſonanti*, or Consonants, are all the *intervals* which pleaſe the ear, whether they be perfect, as the *octave*, and the *fifth*; or *imperfect*, as the *ſixth* and *third*.

The *diſſonanti*, or Dissonance, is in general a falſe *conſonance*, or concord. A *diſſonance* is properly the reſult of a mixture, or meeting of two ſounds, which are diſagreeable to the ear; and the epithet given to all the *ſuperfluous* or *diminiſh'd intervals*, as the *ditones*, *tritones*, *falſe fifth*, *redundant fourth*, *ſeventh*, &c. *Diſſonances* are uſed in *Muſick*, and have a good effect therein, though it be only by accident.

Others they call *vitiati*, or *prohibiti*, i. e. *forbidden*, or which are never to be made in the ſequel of a piece of *Muſick*, through the difficulty of tuning them one after another, either in *aſcending* or *deſcending*. Such are, for example, the *ſixth major*, the *tritone*, the *fifth*, and all the other *ſuperfluous intervals*, the *ſeventh*, the *ninth*, or all thoſe which are at ſo great a diſtance, that the voice cannot naturally reach it. Some are *forbidden* in

aſcending

aſcending, and *permitted* in *deſcending*, ſuch are the *fourth*, the *fifth*, the *ſeventh* diminiſhed, *&c.*

A *compound interval*, or an interval compoſed of ſeveral leſſer, is called SYSTEM, in *Muſick*; ſuch is the *octave*, *&c.* The word is borrowed from the antients, who called a ſimple interval *diaſtem*, and a compound one *ſyſtem*.

There are ſeveral diſtinctions of *ſyſtems*; the moſt remarkable is into *concinnous* and *inconcinnous*.

Concinnous SYSTEMS are thoſe conſiſting of ſuch parts as are fit for *Muſick*; and thoſe parts placed in ſuch an order between the extremes, as that the ſucceſſion of ſounds, from one effect to the other, may have a good effect.

Inconcinnous SYSTEMS are thoſe where the ſimple intervals are *inconcinnous*, or ill diſpoſed betwixt the extremes.

Syſtems, again, are either *particular* or *univerſal*.

Particular SYSTEMS (at leaſt called ſo by the antients) were a compound at leaſt of two *diaſtems*, or intervals, and conſequently of three ſounds at leaſt; ſuch as all kinds of *thirds*; and more all the compounds of three, four, five, *&c.* Diaſtems or intervals, ſuch as are the *fourth*, *fifth*, *ſixth*, and *octave*.

Whence *Boœtius* calls the *modes* or *tones*, *conſtitutions* or *ſyſtems*; ſince in effect a *mode* is properly an aſſemblage of ſeveral ſounds, of ſeveral intervals, and of ſeveral particular ſyſtems, which conſtitute a whole, called *melody* or *ſong*.

Hence we commonly call *general* SYSTEM, a *gamut*, a *ſcale*, an aſſemblage of ſeveral *words*, *ſyllables*, *letters*, *figures*. &c. which ſerve to denote the *grave* and *acute ſounds*, their *differences*, *intervals*, *proportions*, &c. ſo that *ſyſtem* and *gamut* are very near the ſame thing in *Muſick*, *alphabets* are in Grammar; and as there have been different alphabets, according to the diverſity of languages, times, places, *&c.* there have been likewiſe ſeveral ſyſtems of ſounds.

The firſt, or at leaſt the moſt antient we have knowledge of, is that of the *Greeks*, which began at firſt by a tetrachord, *i. e.* a ſequel, of four chords only, the loweſt whereof anſwer'd to our *mi*, and the two others to the notes *fa*, *ſol*, *la*, which is what *Boœtius* calls the order or ſyſtem of *Mercury*, to whom the invention thereof is attributed about the year of the world 2000.

It was ſoon perceived, that that *tetrachord* was not ſufficient to expreſs all the ſounds; therefore ſeveral perſons added, at different times, three other chords underneath the four above, which anſwer'd to what we call, at preſent, *ſi. ut*, *re*, and which formed with them two *tetrachords*, but two *tetrachords* joined; ſince the *mi* ſerved as higheſt chord to the firſt or loweſt; and of the loweſt chord to the higheſt, as in the following example:

Mi fal ſol la
Si ut re mi.

Some time afterwards, *Pythagoras*, according to the moſt common opinion, having eſtabliſhed rules to find the proportion of ſounds, perceived ſoon, that the two extremes of thoſe two tetrachords, *viz. ſi*, and *la*, making the interval of a ſeventh were *diſſonants*, which obliged him to add underneath the moſt *grave chord* of thoſe two *tetrachords* an eighth chord which made the *octave* with the higheſt, *viz. la*, whence it was called *proſlambanomenos*, or *added*.

Laſtly, as in proceſs of time, it was found that thoſe eight ſounds were not ſufficient to expreſs all the ſounds of the human voice, ſeveral perſons added, by degrees, other chords, enough to form, beſides, two other *tetrachords* joined together, the ſounds whereof were an *octave* higher, than the ſounds of the two firſt; thus the *ſyſtem* was found compoſed of fifteen chords, or four *tetrachords*, the two extremes whereof made between themſelves the *diſ-diapaſan* or double *octave*; of which, to pleaſe the curious, I give in the following tables, the *order*, *proportions*, with the name given them in the *modern ſyſtem*.

TABLE *of the fifteen* diatonick chords *of the* ſyſtem *of the antients.*

Tetrachord *of the moſt* acute, *or* higheſt.

The laſt of the moſt excellent, or moſt acute. ——	LA	*Tone minor.*
The penultieme of the excellents.	*Key of* SOL.	
The third of the excellents.	FA	*Semi-tone.*

Tetrachord *of the* disjoined.

The laſt of the disjoined.	MI	*Tone minor.*
The penultieme of the disjoined.	RE	*Tone major.*
The third of the disjoined.	*Key of* UT	*Semi-tone.*
Parameſe. ——	SI	*Tone major.*
Trite ſynemenon.		

It is now the *ſi mi*

Tetrachord *of the* meſe.

Meſe ——	LA	*Tone minor.*
Meſon-diatonos	SOL	*Tone major.*
Parhypato-meſon	*Key of* FA	*Semi-tone.*

Tetrachord *of the* principals.

Hepatemeſon	MI	*Tone minor.*
Hypaton-diatonos	RE	*Tone major.*
Parhypame-hypaton	UT	*Semi-tone.*
Hypate-hypaton	SI	
Proſlambanomenos	LA LA.	

For

For the intelligence of this table, it must be observed, 1. That as the *proslambanomenos*, or added, does not contribute towards forming the first or lowest of the four *tetrachords*, it is separated from it, and was added only to perfect the lowest octave, and make the *mese* the middle of that system, according to its signification, and to join so well the two octaves which compose that said system, that it be the highest chord of the lowest octave; and the lowest chord of the highest octave, according to *Boetius*'s observation.

2. That between the two lowest chords of each *tetrachord*, i. e. between *mi*, *fa*, and *si*, *ut*, there is an interval of five comma's, or of a *semi-tone major*; that between the two highest, as *re*, *mi*, and *sol*, *la*, there is a *tone minor*; and between those which make the middle, such as *ut*, *re*, and *fa*, *sol*, there is a *tone major*, at least in the opinion of the antients.

3. That to discover better the conjunction of the *tetrachords*, I have on purpose redoubled the *mi* of the two octaves, where that conjunction is made, so that the first terminates above the lowest of the *joined tetrachords*, and the second, which notwithstanding is but the emission of the first, begins under the highest of those *tetrachords*. This the antients called the greatest of all *systems*, the *immutable system*, *diatonick*, *pythagorical*, &c.

Thus far, in fact, the system is purely *diatonick*, is composed only of *major tones* and *semi tones*; which nature alone, without the assistance of art, teaches the most ignorant how to tune, provided they have the ear, and the organs of the voice well disposed. But as it was observed, in process of time, that between the *mese* and the *paramese* there was a full tone, which render'd the fourth from *fa* to *si* superfluous, and very disagreeable, a fifth *tetrachord* was invented to make full a middle chord, to divide the interval from the *mese* to the *paramese*, into two *semi-tones*, one *major*, and the other *minor*, called at present *si b*, and which has been marked since by a *b mol*.

This, without doubt, gave occasion to *Timothy* the *Milesian*, to divide likewise in two intervals *ut re*, and *fa sol*, which make the middle of each *tetrachord*, and a *tone major*, and that by means of a double *diezes*, which has been the origin of the chromatick gender; and has been the cause that those sounds or chords, have been called moveable sounds. But he did not divide in the same manner the intervals *re mi*, and *sol la*, which terminate above each *tetrachord*, because they make but one *tone minor*; whence they are called *stable* sounds or chords.

Lastly, one *Olympius*, refining on that division, pretended, that at the example of the *tones-major*, the *semi tones major* should also be divided in two; which engaged him to put, 1. A middle chord, between the two lowest chords of each *tetrachord*, viz. betwixt *si ut*, and *mi fa*. And, 2. Another middle chord, betwixt the second *diatonick* chord of each *tetrachord*, and the *chromatick* chord, which was a *semi-tone* higher than the *diatonick*; which was the origin of the *enharmonick* gender, and consequently of the *enharmonick* and *chromatick* diezes.

The *enharmonick* is one of the three genders of *Musick*, in which the modulation proceeds by little intervals less than the semi-tone, *i. e.* by *quarters of tones*; therefore it has two *diezes* or signs to raise the voice, which are peculiar to it, *viz.* the *dirzes* enharmonick minor, marked by a cross thus +; and the major, or triple diezes marked by a triple cross thus ✕. This gender was antiently much in use in the *Musick* of the *Greeks*, especially for the *dramatick*, or *resitative* musick.

Therefore having gathered those three genders into a single system, each tetrachord was composed, 1. Of four diatonick chords, such are, for example, *si*, *ut*, *re*, *mi*. 2. Of one chromatick chord, which was a semi-tone above the *ut*, called at present *ut diezis*. 3. Of two enharmonick chords, the first whereof divided the semi-tone from the natural *ut*, to the *ut diezis*, into four quarters of a tone. With regard to the intervals from the *ut diezis* to *re*, and from *re* to *mi*, they were not divided in the antient system, because they were thought then *minor intervals*, incapable therefore of that division.

There is to be seen in our plate of *Musick*, Fig. 1. an example thereof by the common notes of *Musick*, where the four white notes are *diatonick*, the two first black, *enharmonick*; and the third black and square *chromatick*.

In process of time the *Latins* finding that those characters, either by reason of the variety and extravagance of their figures, or because of their multitude (which, according to some authors, amounted to 1240) were too difficult to retain, or remember, substituted in their place, the first 15 letters of their alphabet, *viz.* A, B, C, D, E, F, G, H, I, K, L, M, N, O, P, which formed as a *second system*, which notwithstanding differed in nothing from the former but in the number of figures.

Some time afterwards Pope St. *Gregory*, according to *Gaffurius* and *Kircher*, having observed that the letters H I K, *&c.* were properly nothing else but a repetition of a higher octave of the first seven sounds, A, B, C, D, *&c.* reduced all the characters of the sounds to the first seven letters of the alphabet, which were repeated more or less, either high or low, according to the extent of the voices, instruments,

ſtruments, &c. but then they contented themſelves ſtill with marking them, as the *Greeks* uſed to do, above each ſyllable of the texts, which were to be ſung, and always on the ſame line.

But in the eleventh century, about the year 1024, according to *Baronius*, *Guido Aretin* a benedictine monk, born in the city of *Arezzo* in *Tuſcany*, invented a third *ſyſtem*, for which the two preceding ones were ſoon abandoned, and this univerſally received, having ſerved beſides for foundation to the modern one.

This author then, having obſerved, that the names the antients gave to the chords of their *ſyſtem* were too long, ſubſtituted in their place the ſix famous ſyllables, *ut*, *re*, *mi*, *fa*, *ſol*, *la*.

He alſo introduced the uſe of ſeveral parallel lines, on which, and between which, he placed certain round or ſquare points, immediately above each ſyllable of the text, called ſince *notes*, and which by the high or low ſituation of the degrees they occupied on, or betwixt thoſe lines, made at once the diſtinction of the *grave ſounds* from the acute.

But to mark more preciſely which ſound each of thoſe points repreſented, he took the firſt ſix letters of the *Latins*, a-top of which he placed the Γ or *gamma* of the *Greeks*, he named thoſe letters *keys*, becauſe they were to ſerve to open, or give the knowledge of the ſounds, and having joined them with thoſe ſix ſyllables, *ut*, *re*, *mi*, *fa*, &c. he formed a table of them, part whereof may be ſeen in our plate of Miſcellany, *Fig.* 1. and which has been called ever ſince *gamma* or *gamut*, becauſe of the addition of the *gamma* of the *Greeks*, and ſcale for its figure.

He placed, firſt, at the head of each line, and between each of them, one of thoſe ſeven letters, which marked the name to be given to all the points or notes, found on or betwixt thoſe lines, as *Fig.* 2. in our plate of *Muſick*.

Fa mi fa re ut re la fa la re ut re mi fa mi re.

Each *key* giving the opening for the name of the notes, for the quality of their ſound, and for the ſorts of voices which are to ſing them. When immediately after there are ſeveral ♭♭, or ſeveral ♯♯, they are called *tranſpoſed keys* and when there is nothing, *natural*.

To prevent any confuſion which might ariſe from uſing the ſame word in different ſenſes, M. *Malcolm* propoſes the word *mode* to be ſubſtituted inſtead of the word *key*, in the former ſenſe; that is, where it expreſſes the melodious conſtitution of the octave, as it conſiſts of ſeven eſſential or natural notes, beſides the fundamental; and in regard there are two ſpecies of it, he purpoſes, that that with a third G, be called the greater *mode*; and that with a third L, the leſſer *mode*, appropriating the word *key* to thoſe notes of the piece in which the cadence is made; all of which may be called different *keys*, in reſpect of their different degrees of tune. To diſtinguiſh then, accurately, between a *mode* and *key*, he gives us this definition, *viz.* an octave, with all its natural and eſſential degrees, is a *mode*, with reſpect to the conſtitution, or manner of dividing it; but with reſpect to its place in the ſcale of muſick, *i. e.* the degree, or pitch of tune, it is a *key*; though that name is peculiarly applied to the fundamental. Whence it follows, that the ſame *mode* may with different *keys*, i. e. an octave of ſounds, be raiſed in the ſame order and kind of degrees, which makes the ſame *mode*, and yet be begun higher or lower, *i. e.* be taken at different degrees of tune, with reſpect to the whole, which makes different *keys*; and *vice verſâ*, that the ſame *key* may be with different *modes*, i. e. the extremes of two octaves may be in the ſame degree of tune, yet the diviſion of them be different.

Guido Aretin, finding that the *Greeks* had good reaſons to divide in two ſemi-tones the intervals between the *meſe* and *parameſe*, which he calls in his ſyſtem A and B, and the modern *la* and *ſi*, that obliged him, 1. To put ſome time on the degree of B or *ſi*, a *b* to ſhew that from A to B, the voice ſhould not be raiſed but of a ſemi-tone, and as that intonation has ſomething more ſoſter and ſweet than when the voice is raiſed of a full tone, he gave to that *b* the epithet of *mol*; which engaged him, 2. To put in his *gamma* or *gamut*, a column, to be ſeen in our plate of *Miſcellanies*, called for that reaſon the column of *b-mol*.

Laſtly, not ſatisfied with having added under the *proſlambanomenos*, or loweſt chords of the antients, a chord marked with the Γ, and which he called *hypo-proſlambanomenos*, i. e. *ſubadded*, he added to *netehyper-boleon*, or higheſt chord of the *ſyſtem* of the antient *ſyſtem*, four other chords, which formed a fifth *tetrachord*, which he called *tetrachord* of the *ſur-acutes*. So that his *ſyſtem* was compoſed of 22 chords, *viz.* of 20 *diatonick*, which make what has been called ſince the order *b-quarre*, or natural; and the two lowered a ſemi-tone lower than the natural, which changing the natural order nf ſome notes in the order of *b-quarre*, have produced the order called *diatonick b-mol* or ſimply *b-mol*.

Tho' this was the only one followed during very near ſix centuries ſucceſſively, it had three or four very great inconveniences.

To remedy which, it was neceſſary to form a fourth, which I call the modern *ſyſtem*; therefore, 1. As

1. As the ſounds are not naturally found every ſeventh degree, preciſely in the ſame intervals, and can be repeated every *octave*, as it were, *in infinitum*, a ſeventh ſyllable has been added, *viz. ſi*, to the ſix of *Aretin*, which give the facility to expreſs all the degrees of the octave, to fill all the intervals thereof, and conſequently to make that endleſs repetition without changing, but very ſeldom, the name of any of the notes.

2. As it was found that between the chords which are diſtant, or make the interval of a tone, a partition-chord could as well be placed to divide them into two ſemi-tones, as between the *meſe* and *parameſe* of the antients, or which is the ſame thing, betwixt the *la*, and the *ſi*; they have not been contented with adding to the ſyſtem of *Guido Aretin* the chromatick chord, commonly called *b mol*; but have added to it beſides the chromatick chords of the antients, *i. e.* thoſe which divide the major tones or intervals which are in the middle of each tetrachord, into two ſemi-tones, which is effected by raiſing of a ſemi-tone, the loweſt of theſe chords, which is marked with a double diezes, thus, ♯, placed on the left ſide, on the ſame degree, and immediately before that loweſt note. And as it was obſerved, that the tones minor, or intervals, which terminate upwards, each tetrachord is no leſs ſuſceptible of that diviſion, than the tones major, thoſe chromatick chords which were wanted in the ſyſtems of the *Greeks*, have been added to them; ſo that each octave is compoſed at preſent, of 13 ſounds or chords, or of 12 intervals or ſemi-tones, *viz.* of 8 diatonick or natural ſounds, marked with white notes; and of 5 chromatick or diezes, *i. e.* raiſed of a ſemi-tone, marked with black notes, as *Fig.* 6.

3. To remedy the narrowneſs of the antient ſyſtems, and to have different chords enough to multiply the parts which make harmony, the number of thoſe chords has been increaſed by degrees, as far as 29, diatonick or natural; and 20, chromatick. So that inſtead of four tetrachords, or two octaves of the antients, we have at preſent 8 tetrachords, all compoſed like thoſe of the example, *Fig.* 6. of 8 diatonick, and 5 chromatick ſounds.

Thoſe four octaves make the ordinary extent of the modern ſyſtem, or of the organs, or harpſical; and the firſt touch or march of the keys on the left ſide, are commonly called, for that reaſon, *C*, *ſol*, *ut*, or ſimply, *ut*.

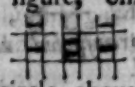
4. Laſtly, as the notes of the ſyſtem of *Guido Aretin*, rendered the tunes ſo uniform, that it deprived them of that variety of motion, ſometimes ſlow, ſometimes quick, which make all the grace or charm thereof, and obliged often to pronounce in a very diſagreeable manner, the ſyllables of the text, the famous *John des Murs*, a *Frenchman*, and a Doctor of *Paris*, invented about the year 1330, or 1333, the different figures of the notes, which ſhew at once how long preciſely each ſound muſt laſt.

There are moſt commonly eight ſorts of notes, the *names*, *figures*, and *meaſures* thereof are as *Fig.* 7.

The ninth figure was of antient uſe, but has been rejected by the moderns.

Mathematicians compute, that one may make 720 changes or varieties with ſix notes, without ever repeating the ſame twice; and that of the notes of each octave, one may make 40320 different tunes or ſongs.

The large note, which is, as it may be ſeen by the figure, a long *ſquare* note, with a tail on the right ſide, and is worth 8 binary meaſures, *i. e.* at two times, is not of any uſe in the modern *muſick*, ever ſince the uſage has prevailed to ſeparate the meaſures, and to bind the rounds with a ſemi-circle to mark the continuity of their ſound. The long, which by inſpection appears to be a ſquare note with a tail on the left ſide, and is worth four binary meaſures, or at two times, and conſequently eight times, unleſs it be bound with a breve or ſquare. The breve of a ſquare figure, called for that reaſon, *ſquare*, by the *French*, is worth under the ſigns of the meaſure at two or four times, two meaſures, under the ſigns of a triple major, or perfect time, is worth three times, when followed by one or ſeveral like ſquares, thus ⊓ ⊓ ⊓ or by a point thus ⊓̇. But when it is followed by a note of leſs value, as by one Ω or two whites, it is worth but two times. That a *minim*, or white, under the ſign *C*, is worth half a meaſure. In the triple is worth, ſometimes one time, ſometimes two: ſometimes alſo, there want two to make one time.

As to the notes bound together, we muſt obſerve, 1. That none but the ſquare notes and the breves are capable of being bound together. their figure allowing that they ſhould be approached ſo near one another, that they appear to make but one figure, only placed on different degrees, thus  without it be neceſſary to put a ſemicircle, above or under it, to mark the binding. 2. That it is only a queſtion here of the binary meaſure, or at two times. 3. That they may be conſider'd as ſimple, as having a tail. 4. As being of different colours.

If they be ſimple, they either go in aſcending, and then they are all worth their natural value, *i. e.* two meaſures each. See A. But if they go in

in deſcending they'll be worth each four meaſures, if there be but two together as B. But if there be three or four together, then the firſt and laſt will be worth each four meaſures; and thoſe in the middle will be worth but two, as A B C, *Fig.* 8.

If they have a tail, either that tail aſcends upwards, and then all the breves or ſquares, as well in deſcending, as in aſcending, are worth each but one meaſure, as D, which was invented becauſe the rounds and minims are not of a figure to be bound together, and that the uſe of the demi-circle or ligature, was not yet introduced. But if that tail hangs downwards, then it gives the breve its natural value of two meaſures, as well in deſcending, as in aſcending, like E, *Fig.* 9.

Laſtly, if they be of different colours, *i. e.* if the firſt be white, and the ſecond black; then the firſt is worth one meaſure, and the ſecond one white pointed, or a time and a half; for example, *Fig.* 10.

From thoſe different *ſyſtems* I'll paſs to the *genders of muſick.*

GENUS, in *muſick*, is a manner of running through different degrees or ſounds, and the ſenſible intervals, which compoſe the extent of the octave, or of its replies.

The antients diſtinguiſhed commonly three kinds of genera's, *viz.* the *diatoniek*, *chromatick*, and *enharmonick*.

The DIATONICK is that genus, the leſſer intervals whereof, are the ſemi tone majors and the tones; and is when the modulation follows the natural order of the ſounds, *i. e.* that diſtance put in it by nature, and which the moſt ignorant obſerve naturally, if they have a good ear, and the organs of the voice juſt. According to that natural order there is a tone between all the notes of muſick, except between *mi*, *fa*, and *ſi*, *ut*, which are ſemi-tones major.

The CHROMATICK is when the modulation proceeds by ſemi-tones major and minor, and generally as often as the *diatonick* or natural order which is between the ſounds is changed in altering them, *i. e.* raiſing them by degrees, or lowering them by *b-mols*.

The *enharmonick* genus is of no uſe at preſent.

The next thing which falls under our conſideration, are the *modes* or *tones*,

MODE, in *muſick*, is a particular manner of beginning, continuing, and ending a ſong, whereby we are engaged to make uſe of certain notes, or chords, preferable to, or oftner than others.

Mode, is defined by ſome authors the particular manner of conſtituting the octave, or the melodious conſtitution of the octave, as it conſiſts of ſeven eſſential, or natural notes beſides the key, or fundamental.

To underſtand well what a *mode* is, according to our firſt definition, we muſt obſerve, that in every tune or ſong there is three principal chords; the firſt, is that whereby a ſong is almoſt always begun, and where it muſt be always ended, wherefore it is called the *final*. The ſecond, is that which is repeated, and which is heard oftner than any other, wherefore it is called the *dominante*. And the third, as being between the other two, is called the *mediante*, and is commonly a third above the *final*. Theſe three chords are otherwiſe called the *eſſential ſounds* of the *mode*.

Among all the ſongs comprized in the extent of the *octave*, there is always one which divides it *harmonically*, i. e. which is juſt a fifth above its loweſt chord; and another which divides it *arithmetically*, i. e. which is a fourth higher than its lower chord; for inſtance, *Fig.* 11.

This double diviſion has formed the two claſſes of *modes*, ſo often mentioned in authors, *viz.* that of the *authentick modes*, and that of the *modes plagal*. For when in a ſong, the ſound, which is one fifth above the loweſt chord of the octave of a *mode*, is repeated and often heard, then a *mode* is *authentick*; and when that which is but of one fourth diſtant from it, or another which makes a third againſt its final is repeated, it is a *plagal mode*; for inſtance, *Fig.* 12.

But as among the ſeven ſpecies of *octaves* abovementioned, there are but ſix which can be divided *harmonically*, or by the juſt fifth, *viz.* the *octaves*, C, D, E, F, G, A, becauſe the fifth of the *octave* B or from *ſi* to *fa* in aſcending, is *diatonically* falſe or diminiſhed: there are alſo but ſix *authentick modes*; as on the other ſide there are but ſix octaves which can be divided *arithmetically*, or by the juſt fourth, *viz.* the octaves C, D, E, G, A, B, becauſe the fourth of the octave F, or from *fa* to *ſi*, in aſcending, is ſuperfluous. There are likewiſe but ſix *plagal modes*; therefore the octaves, C, D, E, G, A, have each two *modes*, one *authentick* and the other *plagal*; the octave F has but one which is *authentick*; and the octave B has but one likewiſe, which is *plagal*; which makes up twelve in number. In *Fig.* 13. is a table which contains all that in a very clear manner.

That which the moderns call *modes*, the antients called *tune*.

TUNE, or *tone*, in *muſick*, is taken for one of its intervals, and even for the firſt, the foundation,

the source, rule, and measure of all other intervals. In that sense the antients, and the mathematicians distinguish two sorts of tunes, *viz.*

The Tone *minor*, whose proportion is *sesquininth*, as from 10 to 9, and which is always the third interval of each tetrachord. And,

The Tone *major*, whose proportion is *sesquieighth*, as from 9 to 8, and which is always the interval of the middle of each tetrachord; as in the following example:

	for 8 to 9.	from 9 to 10.
Mi ———	Fa ———	Sol ——— La.
Semi-tone.	*Tone-major.*	*Tone-minor.*

It is also in that sense, that the moderns (supposing that all the tones in the temperate system be very near equal, (say, that the *tone is the interval between all the degrees or diatonick and natural notes of the octave, except between* mi, fa, *and* si, ut, *which are naturally but* semi-tones.

Lastly, in that sense it is said, that the tone is a second major, because it is the distance from one sound to another, which are distant from one another of 9 comma's, *&c.*

The word *mutation* signifies one of the accidents, which happens in the order of the sounds that compose a song, or a melody; which accident happens by a change; which change is made in four manners.

The first in changing the genus, *i. e.* passing from the *diatonick* to the *chromatick*, or *enharmonick*, and reciprocally from the *chromatick* to the *diatonick*, &c. which is called *mutation by genus.*

The second in making the tune of a very acute sound, to descend to a grave one, the better to express some words of the text: That's called *mutation by system.*

The third is, when to express some passion, *&c.* one passes from a mode into another, as from the mode major to the mode minor, *&c.* which is called *mutatione per tuono o modo.*

The fourth is, when one passes from a manner of singing male and vigorous, called *maniera distendente*, to a sweeter, more languishing, softer, and more effeminate, called *maniera restringente*; or to a tranquil manner which keeps a medium between the two, and is called *maniera quieta.* All these manners, and the other changes, are pathetick, *i. e.* very proper to express the different passions or motions of the soul and heart.

Having thus far consider'd and explained the first branch of the *contemplative part of musick*, I'll pass to the second branch, which treats of the numbers of sounds or notes with respect to time.

The word Time has several significations in *musick*, 1. It signifies in general one of those three signs of the measure, which the *Italians* call *gradi*, viz. *time*, *relation*, and *sincope.*

Time, according to the antients, was a certain sign placed after the key, to mark how many semi-breves or rounds were contain'd in one breve or square. They distinguished two sorts of times, *viz.* perfect and imperfect. A circle whole or cut, perpendicularly, but without a point, was the mark of a perfect time, under which a breve, even without a point, was worth three semi-breves, as A Fig. 8. A semi circle, either whole or cut, was the sign of an imperfect time, under which a breve was worth but two semi-breves or rounds; as B, Fig. 38.

Others more modern, though they agreed with the antients on the division of time into perfect and imperfect, pretended; 1. That the signs of the perfect time, or the example A, had not the virtue of rendering the breve more perfect, unless they were followed by the figures $\frac{3}{2}$ or $\frac{3}{1}$ and 2, that by means of those figures the signs of the example B, had the power to render the breve more perfect, or to give it the value of three semi-breves, as well as those of the example A.

But if the signs of the example B, were not followed by figures, they made them serve not only for the measure of the breve, with regard to the semi-breve, but, likewise, for all notes of less value without distinction; and admitted two kinds thereof, *viz.* the simple C, which the *Italians* call simply *tempo*, and the C cut perpendicularly, which they call *tempo tigliato.*

The simple C is seen in two manners, 1. Turned from the left to the right thus C, and then the *Italians* call it *tempo ordinario*, because it is oftener used than any other; or *tempo alla semi-breve*, because under that sign a semi-breve or round O is worth a measure, or four times, and the other figures in proportion. 2. But it is sometimes found turned from the right to the left, thus Ↄ, then all the figures are diminished of half their value; thus one round O is worth but two times; one minim or white but one time, and thus of the rest.

The C cut, is found likewise either turned from the left to the right, thus ¢, or from the right to the left, thus ↁ. When on the left, the *Italians* call it, *tempo alla breve*, because antiently, all the figures under that sign were diminished of half their value; but at present it marks that the measure must be beat at two times grave, or at four times very quick, unless there be *largo*, *adagio*, *lento*, or some other term, which advises to beat the measure slowly. And when with that sign the words *da capella*, and *alla breve*, are seen, it marks two very quick times; which it marks, likewise

likewiſe, when turned upſide down; but it is ſeldom found in that ſituation.

Laſtly, others ſtill more modern, divide times into two ſingle ſpecies; the firſt is *tempo maggiore*, or *time major*, which is marked by a ϕ cut, and ſignifies, that all the notes can be ſung *alla breve*, i. e. in making them worth but half their value. The ſecond is *tempo minore*, or *time minor*, which is marked by a ſingle C, under which all the notes are worth their natural value. And if one and the other of thoſe two times are followed by three, or any of the other ſigns, I'll mention when I ſpeak of the *triple*, then they are called *ternary major*, or *minor time*.

2. The word *time* ſignifies not only one of the ſigns of the meaſure, but likewiſe the aliquot parts it is compoſed of: therefore we ſay, that there are meaſures at *two*, at *three*, at *four times*, &c. becauſe the hand by its different motions marks as many parts in each meaſure.

But it muſt be obſerved, that among the different times which compoſe the meaſure, there are ſome more proper than the others, to place a *conſonance* or a good *accord*; which for that reaſon, are called *tempo*, or *tempi di buono*, i. e. a certain *time* of the meaſure which is good, and more proper to certain things than another.

3. We find ſometimes after the *recitative* of the *Italians*, theſe words *a tempo*, *or a tempo giuſto*, which mark that the meaſure muſt be beat juſt, and the times thereof rendered very equal; when as in the *recitative* a greater regard is to be had to the expreſſion, than to the juſtneſs or equality of the *times* of the meaſure.

As *time*, among the antients was properly the meaſure of the *breve* and *ſemibreve*; *prolation*, or the point thus called (which was marked either in a circle or ſemicircle, thus, ⊙ ☾) was the meaſure of the *ſemibreve*, and of the *minim*.

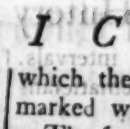
There were two ſorts of *prolations*, viz. the *perfect*, and *imperfect*.

The *perfect prolation*, was marked after the key, by a point within a circle, thus ⊙, or within a ſemi-circle, thus ☾, and then the *ſemi-breve* or round was worth three *minims* or whites; wherefore that circle was commonly accompained with 3 or $\frac{3}{2}$ or $\frac{3}{4}$ which are the ſigns of three times for each meaſure; and which is demonſtrated in A, fig. 39.

The *imperfect prolation* was marked like the *time*, either by a circle, thus O, or by a ſemi-circle, thus C, both without a point; and then the *ſemi-breve* or *round*, was worth but two *minims* or *whites*, as is ſeen in B, fig. 39.

The modern *Italians* have ſtill often in their muſick two ſorts of *prolations*, very near like to that of the example A, fig. 39. The firſt, which they call *prolazione maggiore perfetta*, is marked with a ⊙ and $\frac{3}{1}$;

The ſecond, they call *prolazione minore perfetta*, is marked with a C and $\frac{3}{1}$ or $\frac{3}{2}$, and ſometimes with a ☾ and $\frac{3}{4}$. but in both the round Ω, is worth three times, even without a point; and its pauſe a meaſure, The white is wor h a time, and its pauſe a time; and the reſt of the figures in proportion, as in our plate Fig. 40.



From this I'll paſs to the *meaſure*, which is the interval, or ſpace of time, which the perſon who beats time, takes between the raiſing and falling of his hand or foot, in order to conduct the movement, ſometimes quicker and ſometimes ſlower, according to the kind of muſick, or the ſubject that is ſung or played.

The *meaſure*, is that which regulates the time we are to dwell on each note.

The ordinary or common *meaſure*, is one ſecond, or ſixtieth part of a minute, which is nearly the ſpace between the beats of the pulſe or heart; the ſyſtole or contraction of the heart anſwering to the elevation of the hand, and its diaſtole or dilation to the letting it fall. The *meaſure* uſually takes up the ſpace that a pendulum of two feet and a half long, employs in making a ſwing or vibration.

There are *meaſures* at two times or *binary*; at three times, or *triple*; at four, ſix, eight, nine, and twelve times; and *meaſures* for all ſorts of times.

Binary, or *double meaſure*, is that wherein the riſe and fall of hand are equal.

Ternary, or *triple meaſure*, is that which is beaten in three equal times, either *ſimple* or *compoſed*; the *firſt* whereof is made by one fall of the hand; the *ſecond*, by turning it a little aſide, and the *third* in raiſing it.

Towards the middle of the laſt century, ſo many ſpecies of *triples* were invented, that to give the explication thereof with ſome order, I am obliged to diſpoſe them under three different claſſes, *viz.* of *ſimple*, *compoſed*, and *mixt triples*.

First Class.

Of ſimple triples.

I call *ſimple triples* thoſe which have but three *ſimple times*, i. e. whoſe times cannot be ſub-divided into three other equal notes. I find five different ſorts of them in authors, to mark five degrees of ſlowneſs or quickneſs. The firſt is that called the *grand triple*, or *triple of the rounds*, or of *three for one*; thus called becauſe the *breves* or *ſquares*, and the *ſemibreves*, or *rounds*, are predominant in it, and the meaſure thereof muſt be beat *ſlowly* and *gravely*, ſo that each time be conſequently

quently greater and longer than those of the other following *triples*.

Our antients, and some *Italians* still, have four different signs to mark the *tripola maggiore*; according to which they gave it four different names, as in the table, *Fig.* 40. *Musick plate.*

Of those four signs, the moderns have retained but this $\frac{3}{2}$ without putting before, either the circle O, or the semi-circle C, *&c.* those two figures of arithmetick denoting clearly enough, that three rounds, instead of one, are wanted for one *measure*; and that a *breve* being worth two *rounds*, is consequently worth by itself two times, and three when followed by a point; and the other figures in proportion.

The second sort of *simple triple*, is that called by the Italians, *tripla minore*, or *triple minor*. Our antients had likewise four different signs for that sort of *triple*, according to which they gave them three different names; as is seen in the table, Fig. 21.

Of those four signs the moderns have retained but this $\frac{3}{2}$ C, whence in all appearance it has borrowed its name of *double triples*, even without putting before, the semi-circle C; those two figures being sufficient to mark that three whites, instead of two, are wanted for a measure; and that a *semi-breve*, or *round*, having by itself the value of two whites, is consequently worth two times and three times, if it be followed by a point; and thus in proportion of the other figures.

The third kind of *simple triple*, is that called by the Italians, *tripola picciola*, *small triple*: it is marked thus C $\frac{3}{4}$, or simply $\frac{3}{4}$, or more simply 3.

When that *triple* is marked by $\frac{3}{4}$, it is proper for tender expressions, and the movement thereof must be moderate, neither *too quick*, nor *too slow*, &c. When marked by a single 3, the movement thereof is most commonly a little merry; wherefore it is most commonly used for merry and lively dances.

The fourth kind of *simple triple* is that called by the Italians *tripola crometta*, or *triple of crotchets*; because, without doubt there is no other sign, but these two figures thus C $\frac{3}{8}$ or thus $\frac{3}{8}$, which mark that three crotches make a measure, whenas eight are wanted in the *binary measure*; that therefore six *double crotchets*, and twelve *triple crotchets*, make likewise a measure; and that a *single black* is worth two times, and three times are a measure when it is punctuated.

Lastly, the fifth kind of *simple triple*, is that which the *Italians* call *tripola semi crometta*, or *triple of double crotchets*. Its sign is composed of these two numbers thus C $\frac{3}{16}$, or thus $\frac{3}{16}$, which mark that three double *crotchets* make one measure, whenas 16 of them are wanted in the binary measure; therefore that six *triple crotchets*, and one punctuated *crotchet* make also a measure; that a single *crotchet* is worth but two times, *&c.* for example, Fig. 35.

This *triple* is proper for very *quick* and *rapid expressions*, since each time of the measure must last no longer than a double *crotchet* lasts in the *ordinary measure*.

Second Class.

Of the composed triples.

I call *composed triples*, those which have not only, and are but at three times, like the simples; but each time whereof can likewise be sub-divided into three other equal times or notes, and are called in general, by the Italians, *nonupla*, of which there are but three sorts in use.

The *first* is that called by the Italians *nonupla di semi-minima*, and by the French *triple of* 9 *for* 4, or *nine four*; because it has for sign those two numbers thus, C $\frac{9}{4}$, or thus $\frac{9}{4}$, which mark that 9 black notes are wanted in each measure, *viz.* three at each time instead of two: this triple is proper for tender expressions, and is to be beat moderately, neither too slow or too quick; as in Fig. 29.

The *second* is that which the *Italians* call *nonupla di croma*, or *sisqui ottava*, and the *French* triple of 9 for 8, or only *nine eight*; because that *triple* has for sign those two numbers thus, C $\frac{9}{8}$, or thus $\frac{9}{8}$, which mark that there wants *nine crotchets*, viz. three in each time, to make up the measure instead of four. This *triple* is proper for merry expressions, and ought to be beat *quickly* and *merrily*.

The *third* is that called by the Italians *nonupla di semi-croma*, or *triple of* 9 *for* 16; because it has for sign those two numbers, thus C $\frac{16}{9}$ or thus $\frac{16}{9}$; which mark that there wants *nine double crotchets* for a measure, *viz.* three at each time instead of eight. This triple is proper for very quick and very rapid expressions. As is seen, Fig. 32.

Five other kinds of *simple triples*, have been invented to mark the different degrees of slowness or quickness, which must be given to the measure; I believe that it would be proper to introduce two other kinds of *compound triples*, and add to the three signs here above $\frac{9}{4}$ $\frac{9}{8}$ $\frac{9}{16}$ these two other signs $\frac{9}{2}$ and $\frac{9}{1}$. The first whereof could be very well called *triple* of 9 for 1; because it would have those two numbers for signs, thus $\frac{9}{1}$, which would shew, 1. That for a measure there should be wanted 9 semi-breves or rounds, *viz.* three at each time. 2. That for one time, a breve, or square with

with a point ſhould be wanted; becauſe without a point it would be worth but two thirds of a time, &c. 3. That the batoon would be worth but two meaſures; the ſemi-batoon one meaſure; the pauſe one time of the meaſure; and the half pauſe one third of a time, or a ninth part of the meaſure, &c. That kind of triple would be very proper for ſorrowful and languiſhing expreſſions, and generally for all thoſe, which want a ſlow meaſure, ſee Fig. 33.

The ſecond would be called triple of 9 for 2, becauſe it would have thoſe two numbers for ſigns, thus $\frac{9}{2}$; which would ſhew, 1. That for one meaſure, 9 minims or whites ſhould be wanted, viz. three for each time. 2. That for one time there ſhould be wanted a ſemi-breve or round, with a point, becauſe without a point it would be worth but two thirds of a time, &c. 3. That the batoon would be worth but two meaſures; the ſemi-batoon one meaſure; the pauſe one time; and the half-pauſe one third of a time, or a ninth part of the meaſure; as in Fig. 34. This triple would be very proper for the movements which the *Italians* expreſs by the words *lento*, *adagio*, &c.

Third Class.

Of triples mixt.

I call *triples mixt*, thoſe which participate of two ſorts of meaſures, *i. e.* which, for the manner of beating the meaſure thereof, follow the binary meaſure; and for the value of their notes or figures, follow the ternary meaſure. But there are two ſorts of binary meaſures, viz. a ſimple one compoſed of two times; and one compoſed which has four times; which obliges me to divide this claſs into two articles.

Article I.

Of triples at two times.

Theſe we call a *meaſure at ſix times*, though improperly, for they ſhould rather be called binary triples, &c. we find but three kinds of them in authors; but we have ſome reaſon to add two more to them; therefore, I'll explain them all five in this article.

The firſt is that which we could very well call triple of 6 for 1, becauſe it ſhould have for ſign thoſe two numbers thus, $\frac{6}{1}$.

The ſecond ſort is that, which could be called triple of 6 for 2; becauſe it would have for ſign thoſe two numbers, thus, $\frac{6}{2}$.

The third kind of binary triple is that which we call of 6 to 4, becauſe it has for ſign thoſe two numbers thus, C $\frac{6}{4}$ or $\frac{6}{4}$. This triple is commonly uſed for tender affectuous motions; for inſtance, *Fig.* 38.

The fourth ſort of binary triple is that we call of ſix for eight, becauſe it has for ſigns thoſe two numbers, thus C $\frac{6}{8}$ or $\frac{6}{8}$. This triple is proper for merry, lively, and animated expreſſions; and conſequently beat pretty quick. See *Fig.* 39.

The fifth ſort of binary triple, is that called of ſix for ſixteen; becauſe it has for ſign thoſe two numbers, thus, C $\frac{6}{16}$ or $\frac{6}{16}$. This triple is for movements and expreſſions of the greateſt rapidity, which the *Italians* mark by the ſuperlative term *preſtiſſimo*. See *Fig.* 40. and *Fig.* 41. is a table of the ſeſtuple, or binary triples.

Article II.

Of triples beaten at four times.

The firſt is that which could be called in *Italian*, *dodecupla di ſemi-brevi*, and in *Engliſh*, triple of 12, for 1, becauſe it ſhould have for ſign thoſe two numbers, thus $\frac{12}{1}$, which would be very proper for very melancholick, and ſlow expreſſions, &c. See *Fig.* 43.

The ſecond ſpecies of triples at four times, is that which could be very well called in *Italian*, *dodecupla di minime*, and by us triple of 12 for 2. Becauſe it would have for ſign thoſe numbers, thus $\frac{12}{2}$, which would be proper for grave and ſlow expreſſions, &c. See *Fig.* 44.

The third ſpecies of triples at four times, is that which the *Italians* call *dodecupla di Semi-minime*, and we triple of 12 for 4. Becauſe it has for ſign thoſe two numbers, thus C $\frac{12}{4}$ or $\frac{12}{4}$, which is proper for tender and affectuous expreſſions, and ſometimes for thoſe which are lively and animated, &c. See *Fig.* 45.

The fourth ſpecies of triples at four times, is that which the *Italians* call *dupla di chrome*, and the *French*, triple of 12 for 8, becauſe it has thoſe two numbers for ſign, thus C $\frac{12}{8}$ or thus $\frac{12}{8}$. This triple is very proper for lively and merry expreſſions; which notwithſtanding the *Italians* uſe it very often for tender and affectuous expreſſions, adding to it the words *adagio*, *affettuoſo*, or ſome other, for of itſelf it denotes mirth. See *Fig.* 46.

Laſtly, the fifth ſpecies of triple at four times, is that called by the *Italians*, *dodecupla di ſemi-crome*, and by thus, triple of 12 for 16; becauſe it has for ſign thoſe two numbers marked thus C $\frac{12}{16}$ or thus $\frac{12}{16}$. This triple is proper for very quick, and very rapid expreſſions; which the *Italians* mark by the ſuperlative *preſtiſſimo*. See *Fig.* 47.

From the triples I'll paſs to *ſyncope*, called alſo *ſyncopation*.

Syncope ſignifies the diviſion of a note, uſed when two or more notes of one part anſwer to a ſingle one of the other, as when the ſemi breve of the one anſwer to two or three notes of the other.

But

But to have a right understanding of the word *syncope*, it must be observed first, that every bar in common time has two parts, one of which is when the hand falls, the other when it rises.

Secondly, that any note which contains two times, or a rise and fall of the hand, is divisible into two parts, for the first whereof the hand goes down, for the last it rises.

Thirdly, that every note (though of less value than a semi-breve) is divisible into two others, the first whereof must be during the first part of the measure, or with a rise or fall of the hand, the other part in the second.

The following is a table from *Documenti Armonici di Angelo Bernardi*; which shews at once what the concords are, that resolve each distance the more naturally, whether the upper or lower part of the *syncope*.

When the treble or upper part syncopes.	*When the bass or lower part syncopes.*
The 2d is resolved by unison.	The 2d is resolved by the 3d.
The 4th by the 3d.	The 4th by the 5th.
The 7th by the 5th or 6th.	The 7th by the 8th.
The 9th by the 8th.	The 9th by the 10th.
The 11th by the 10th.	The 11th by the 12th.

When two successive notes of equal value, as to time, are used, one of which being a discord, supplies the other a concord, it is called *supposition*.

There are several kinds of *supposition*. The first, when the parts proceed gradually from concord to discord, or *è contra* from discord to concord, the intervening discord serving only as a transition to the following concord.

Another kind is, when the parts do not proceed gradually from discord to concord, and *vice versâ*, but descend to it by the distance of a third.

A third kind like the second, is, when the rising to the discord is gradual, but the descending from it to the following concord is by the distance of a fourth.

A fourth kind very different from all the rest, is, when the discord falls on the accented part of the measure, and the rising to it is by the interval of a fourth; in which case it is absolutely necessary to follow it immediately by a gradual descent into a concord, which has just been heard in the harmony, to make the preceding discord pass without notice, and only seem a transition into the concord.

When three notes are played to one, they must all be of equal value, as in the measure $\frac{6}{4}$, or $\frac{3}{2}$, *&c.*

If these three notes of equal value, be preceded by a pause equal to one of them, the first of those left may be a discord, because the pause is reckoned, in the place of the concord. See *Fig.* 49.

To dispose to practice the rules heretofore described, into airs, songs, *&c.* either in one or more parts, to be sung by a voice, or played on instruments, is the *practical part of Musick*, or the art of *composition*.

Zarling defines *composition*, the art of joining and combining concords and discords together.

Under *composition* are comprehended the rules, 1. Of *melody*, or the art of making a single part, that is, contriving and disposing the simple sounds, so as that their succession and progression may be agreeable to the ear.

2. Of *harmony*, or the art of disposing and concerting several single parts together; so as that they make one agreeable whole.

The words *concord* and *harmony* do really signify the same thing, though custom has made a little difference between them; *concord* is the agreeable effect of two sounds in consonance, and *harmony* the effect of any greater number of agreeable sounds in consonance.

Harmony is well defined the sum of concords, arising from a continuation of two or more concords; *i. e.* three or more simple sounds striking the ear altogether, and different compositions of concords make different *harmony*.

To understand the nature, and to determine the numbers and preference of *harmonies*, it is to be considered, that in every compound sound, where there are not more than three simple ones, there are three kinds of relations, *viz.* primary relation of every simple sound to the fundamental or gravest, whereby they make different degrees of concord with it; the mutual relations of the acute sounds, each with the other, whereby they mix concord or discord into the compound; and the secondary relation of the whole, whereby all the terms unite their vibrations, or coincide more or less frequently.

Suppose, *e. g.* four sounds, A, B, C and D, whereof A is the gravest, B the next, then C and D the acutest; here A is the fundamental, and the relations of B, C, and D are primary relations: so if B be a third greater above A, that primary relation is 4 : 5; and if C be a fifth to A, that primary relation is 3 : 2; and if D be an octave to A, that is 2 : 1: for the mutual relations of the acute terms, B, C, D, they are had by taking primary relations to the fundamental, and subtracting each lesser from each greater, thus B to C is 5 : 6, so a third lesser; B to D, 5 : 8, a sixth lesser, *&c.* And lastly, to find the secondary relations of the whole, seek the least common dividend to all the lesser terms or numbers of the primary relations,

i. e.

i. e. the leaſt number that will be divided by each of them exactly, this is the thing ſought; and ſhews that all the ſimple ſounds coincide after ſo many vibrations of the fundamental, as the number expreſſes.

So in the preceding example the leſſer terms of the three primary relations are 4, 2, 1, whoſe leaſt common dividend is 4, conſequently at every fourth vibration, of the fundamental, the whole will coincide.

HARMONY is divided into *ſimple* and *compound*.

Simple HARMONY is that to which there is no concord to the fundamental above an octave.

The ingredients of *ſimple harmony*, are the ſeven original ſimple concords, of which there can be but eighteen different combinations that are *harmony*; which are given in the following table from Mr. *Malcolm*.

The TABLE *of ſimple* harmonies.

Secondary Relations.			*Secondary Relations.*			
5th	8ve	2	3d grt. 5th	4	3d grt. 5th	8ve
4th	8ve	3	3d leſs. 5th	10	3d leſs. 5th	8ve
6th greater	8ve	3	4th 6th grt.	3	4th 6th grt.	8ve
3d greater	8ve	4	3d grt 6th leſs.	12	3d grt. 6th grt.	8ve
3d leſſer	8ve	5	3d leſs. 6th leſs.	5	3d leſs. 6th leſs.	8ve
6th leſſer	8ve	5	4th 6th leſs.	15	4th 6th leſ.	8ve

Compound HARMONY is that which to the *harmony* of an octave adds that of another.

HARMONY again may be divided into that of *concords*, and that of *diſcords*.—The firſt is that which we have hitherto conſidered, wherein nothing but concords are admitted.——The ſecond is that wherein diſcords are uſed, and mixed with concords.

The firſt is alſo called *ſimple counterpoint*, and the ſecond *figurative counterpoint*.

Simple counterpoint conſiſts of the imperfect, as well as perfect concords, and may be therefore denominated perfect or imperfect, according as the concords are whereof it is compoſed

The *figurative counterpoint* is of two kinds; in one diſcords are introduced occaſionally as paſſing notes, ſerving only as tranſitions from concord to concord; in the others, the diſcord bears a chief part in the harmony.

The TABLE *of* Concords.

Ratio's of Vibrations.	*Coincidences.* *Grave Terms.*	*Acute*	
Uniſon,	1	1	0
Octave, 8ve,	2	1	16
Fifth, 5th,	3	2	30
Fourth, 4th,	4	3	20
Sixth greater, 6th grt.	5	3	20
Third, greater, 3d grt.	5	4	15
Third leſſer, 3d leſſer,	6	5	12
Sixth leſs, 6th leſſer,	8	5	12

Grave Acute Lengths.

Concords are divided into *ſimple*, or *original* and *compound*.

A *ſimple* or *original* CONCORD, is that whoſe extremes are at a diſtance leſs than the ſum of any two other *concords*.

On the contrary, a compound *concord* is equal to two or more ſimple *concords*.

Other maſters of *muſick* ſtate the diviſion thus, an octave 1 : 2, and all the other inferior *concords* above expreſſed, are ſimple or original *concords*; and all greater than an octave, are called *compound concords*, as being compoſed of, and all equal to the ſum of one or more octaves, and ſome *ſimple concord* leſs than an octave, and uſually in practice denominated from that *ſimple concord*.

As to the compoſition and relations of the original *concords*, by applying to them the rules of the addition, and ſubſtraction of intervals, they will be divided into ſimple and compound, according to the firſt and more general notion, as in the following table:

Simple Concords.	*Compound Concords.*	*Octave compoſed.*
5 : 6 a 3d leſs	5th	
4 : 5 a 3d gr.	6th leſs. { 3d gr. & 3d leſs. / 4th and 3d leſs. }	of { 5th & 4th. / 6 gr. 3d leſs or 3d gr. }
3 : 4 a 4th.	6th gr. { 4th and 3d gr. }	3d leſs 4th.

Diſcords are in *muſick*, what ſtrong ſhades are in *painting*.

Moſt pieces of *muſick* are compoſed in parts, the four principal thereof are the *treble*, *tenor*, *countertenor*, and *baſs*.

TREBLE is the higheſt, or acuteſt part of the four parts in ſymphony; or that which is heard cleareſt in a concert. In this ſenſe we ſay, a *treble* violin, *treble* hautboy, *&c.*

The *treble* is divided into firſt or higheſt *treble*, and ſecond or loweſt *treble*; half *treble* is the ſame with the *counter-tenor*.

The TENOR is the firſt mean or middle part, or that which is the ordinary pitch of the voice, when neither raiſed to a *treble*, or lowered to a *baſs*.

The *tenor* is commonly marked in thorough baſs with the letter T.

The BASS is that part of a concert, which is moſt heard, which conſiſts of the graveſt and deepeſt ſounus.

Muſicians hold the *baſs* to be the principal part of the concert, and the foundation of compoſition; though ſome will have the *treble* the chief part, which others only make an ornament.

A *ſecond*, or *double baſs*, is called *counter-baſs*, where there are ſeveral in the ſame concert.

The

The *thorough-baſs* is the harmony made by the *baſs-viols*, continuing to play both while the voices ſing, and the other inſtruments perform their parts, and alſo filling up the intervals, when any of the other parts ſtop.

M. *Breſſard* obſerves the *thorough-baſs* to be part of the modern muſick, firſt invented in the year 1600, by an *Italian* called *Ludovicus Viadana*, it is played by cyphers marked over the notes on the organ, ſpinet, harpſichord, theorbo, harp, *&c.* and frequently, and ſimply, and without cyphers on the baſs-viol, baſſoon, *&c.*

Beſides theſe four principal parts, there is, in a concert, what we call *chorus*, which is, when at certain periods of a ſong, the whole company are to join the ſinger, in repeating certain couplets or verſes.

The Vocal Musick is muſick ſet to words, eſpecially verſes, to be performed with the voice, in contradiſtinction to inſtrumental muſick, compoſed for, and to be executed by inſtruments without ſinging.

In the *vocal muſick*, there are pieces compoſed for one, two, three, or more *voices*.

A ſong or compoſition, to be performed with two *voices*, or in two parts only, one ſung, the other played on an inſtrument, is called a *duo*; and likewiſe when two *voices* ſing different parts, accompanied with a third which is a thorough-baſs. Uniſons and octaves are rarely uſed in *duo's* except at the beginning and the end.

A piece of muſick to be performed by three *voices*, or more properly a compoſition conſiſting of three parts only, is called *trio*, which is the fineſt kind of compoſition, and ought to be the moſt regular of all.

Next to *vocal muſick* is that called *inſtrumental*, played on inſtruments; which are machines invented and diſpoſed by art in ſuch a manner, as to imitate the human voice, or ſupply its place.

There are many kinds of inſtruments, which are ordinarily reduced into three claſſes or orders.

The firſt claſs was called by the Greeks *enchorda* or *entata*; which are inſtruments with chords, and to be play'd on with the fingers, as the *lute*, *harp*, *theorbo*, *guitar*, and others; or by a bow, as *violins*, *baſs-viols*, *trumpets marine*, &c. or by means of jacks armed with quills-ends, as *ſpinnets*, *harpſichords*, &c.

The ſecond kind, *emphyſoomena*, *pneumatica*, or *empneuſta*, made to ſound by the wind, and that either natural from the mouth, as *flutes*, *trumpets*, *French-horns*, *hautboys*, *baſſoons*, *ſerpents*, *ſackbuts*, *horns*, &c. or artificial by means of bellows, as the *bagpipe*, and that which by way of excellence was called the *organ*, by the *Italians* called *ſtromenti da fitto*.

The laſt the *Greeks* called *krouſta*, the *Latins pulſatilia*, and we *Inſtruments of Percuſſion*, becauſe made to ſound by beating them either with the hand, as *drums*, *tabors*, *tymbals*, &c. or with a little ſtick, or ſmall iron rod, as *pſaltery* and *ſymbal*; or by a feather, as the *cyſtrum* and *dulcimer*; or by ſtriking them with hammers, as *bells*, &c.

From this general deſcription of inſtruments, I'll enter into a more particular one, and examine apart every one of the *inſtruments* contained in each claſs; beginning by the firſt claſs, and in that claſs by the *lute*.

The Lute, from the *Arabick alloud*, is a muſical inſtrument of the ſtring-kind, which had antiently but five rows of ſtrings; though in courſe of time, four, five, or ſix more have been added. It conſiſts of four principal parts; the table, the body or belly, which has nine or ten ſides; the neck which has nine or ten ſtops or diviſions marked with ſtrings; and the head or croſs, wherein are ſcrews, for raiſing or lowering the ſtrings to the proper tune. In the middle of the table is a roſe or paſſage for the ſound: there is alſo a bridge that the ſtrings are faſtened to, and a piece of ivory between the head and the neck, to which the other extremities of the ſtrings are fitted. In playing the ſtrings are ſtruck with the right hand, and with the left the ſtops are preſſed.

The *lutes* of *Bologna* are eſteemed the beſt.

The Theorbo, from the French *teorbe* or *theorbe*, is a muſical inſtrument made in form of a large lute, except that it has two necks, the ſecond and longer whereof ſuſtains the four laſt rows of chords, which are to give the deepeſt ſound. It has ſucceeded to the lute, in the playing of thorough baſſes.

The *theorbo* is alſo much out of uſe; the *baſſoon* ſupplying well its place, and with much more agreement.

The Guitar has five double rows of ſtrings, of which thoſe that are baſs are in the middle, unleſs it be one for the burthen, an octave lower than the fourth.

This inſtrument was firſt uſed in *Spain*.

The Harp is a muſical inſtrument, of a triangular figure, and placed an end between the legs, to be played on.

There is ſome diverſity in the ſtructure of *harps*, that called the *triple harp* has ſeventy-eight ſtrings or chords which make four octaves; the firſt row

is

is for ſemitones, and the third is uniſon with the firſt. There are two rows of pins or ſcrews on the right ſide, ſerving to keep the ſtrings tight in their holes, which are faſtened at the other end to three rows of pins on the upper ſide.

This inſtrument is ſtruck with the fingers and thumbs of both hands, its muſick is like that of the ſpinet; all its ſtrings go from ſemitone to ſemitone; whence ſome called it the inverted ſpinet.

The *Arpi*, a people in *Italy*, were the firſt that invented it.

The VIOLIN, VIOLINO, *fiddle*, is a muſical inſtrument, mounted with four ſtrings or guts; and ſtruck or played with a bow. The *violin* conſiſts, like moſt other inſtruments, of three parts, the *neck*, the *table*, and the *ſound board*.

At the ſides are two apertures, and ſometimes a third towards the top, ſhaped like a heart.

Its bridge, which is below the apertures, bears up the ſtrings, which are faſtened to the two extremes of the inſtrument; at one of them by a ſcrew, which ſtretches or looſens them at pleaſure.

The ſtyle and ſound of the *violin*, is the gayeſt and moſt ſprightly of all other inſtruments; and hence it is of all others, the fitteſt for dancing.

It generally makes the *treble*, or higheſt parts in concerts. Its harmony is from fifth to fifth. Its play is compoſed of baſs, counter-tenor, tenor, and treble; to which may be added, a fifth part: each part has four fifths, which riſe to a greater ſeventeenth.

In compoſitions of *muſick*, violin is expreſſed by V, V V denote two *violins*.

The word *violin* alone, ſtands for *treble violin*; when the *Italians* prefix *alto*, *tenore*, or *baſſo*, it then expreſſes the *counter-tenor*, *tenor*, or *baſs-violin*.

In compoſitions where are two, three, or more different *violins*, they make uſe of *primo*, *ſecundo*, *terzo*, or of the characters I. II. III. or 1. 2. 3, *&c.* to denote the difference.

The *violin* has only four ſtrings, each of a different thickneſs, the ſmalleſt whereof makes the E *la mi* of the higheſt octave of the organ; the ſecond a fifth below the firſt, makes the A *mi la*; the third a fifth below the ſecond, is D *la re*; laſtly, the fourth a fifth below the third, is G *re ſol*.

The *largeſt* or *fourth ſtring*, has four notes belonging to it, *viz.* G *re ſol*, or G, which is to be played open; A *la mi re*, or A muſt be ſtopped with the fore-finger of the left hand, almoſt at the diſtance of an inch from the nut; B *fa be mi*, or B, with the ſecond finger about half an inch from the firſt, and C *ſol fa ut*, with the third finger cloſe to the ſecond.

The *third* has alſo four notes, D *la ſol re* is ſtruck open; E *la mi* muſt be ſtopped with the fore-finger about an inch from the nut; F *ut fa*, with the ſecond finger cloſe to the firſt; and G *re ſol ut* (on which note the cleff is commonly marked) with the third finger about three quarters of an inch from the ſecond.

The *ſecond ſtring* has four notes, A *la mi re*, or A is the open ſtring; B *fa be mi*, or B, is with the fore-finger, about an inch from the nut; C *ſol fa ut*, is the ſecond finger cloſe to the firſt; and D *la ſol re*, or D, is the third finger about three quarters of an inch from the ſecond.

The *leaſt* or *treble ſtring*, has uſually ſix notes, E *la mi*, open; F *fa ut*, or F, the fore-finger very near the nut; G *ſol re ut*, or G, the ſecond about three quarters of an inch from the firſt; A *la mi re* or A, with the third finger at the ſame diſtance from the ſecond; B *fa be mi*, with the little finger half an inch from the third; and laſtly, C *fa ut*, you muſt ſtretch the little finger about a quarter of an inch further, than for B *fa be mi*. But here it muſt be obſerved, that all the notes on the *treble ſtring*, except E *la* or E, are term'd *in alt* for diſtinction's ſake.

Moſt nations ordinarily uſe the cleff G *re ſol*, on the ſecond line, to note the *muſick* for the *violin*, only in *France* they uſe the ſame cleff at the firſt line at bottom: the firſt method is beſt, where the ſong goes very low, and the ſecond where it goes very high.

The VIOLONCELLO of the *Italians*, is properly our fifth *violin*, which is a little baſs *violin*, half the ſize of the common baſs *violin*, and the ſtrings bigger and longer, in proportion; and conſequently its ſound an octave lower than that of our baſs *violin*, which has a noble effect in great concerto's.

The VIOL, *viola*, is a muſical inſtrument of the ſame form with the *violin*: and ſtruck like that with a bow.

There are *viols* of divers kinds (1.) The firſt and principal among us, is the *baſs-viol*, called by the *Italians*, *viola de gamba*, or the *leg-viol*, becauſe held between the legs. It is the largeſt of all, and is mounted with ſix ſtrings. Its neck is divided in half notes, by ſeven frets fixed thereon. Its ſound is very deep, ſoft and agreeable. The tablature or *muſick* for the *baſs-viol* is laid down on ſix lines or rules,

2. The *love-viol*, *viola d' amore*, which is a kind of *triple-viol*, or violin, having ſix braſs or ſteel ſtrings, like thoſe of the harpſichord. It yields a kind of ſilver ſound, which has ſomething in it very agreeable.

3. Their *viola prima*, or *firſt viol*, is really our *counter-tenor* violin; at leaſt they commonly uſe the

the cleff of C *ſol ut* on the firſt line, to denote the piece intended for this inſtrument.

4. *Viola ſecunda*, is much the ſame with our tenor violin; having the cleff of C *ſol ut*, on the ſecond line.

5. *Viola terza*, is nearly our fifth violin; the cleff C *ſol ut*, on the third line.

6. *Viola quarta*, or *fourth viol*, is not known in *France*, or *England*: though we frequently find it mentioned in the *Italian* compoſitions; the cleff on the fourth line.

7. Laſtly, their *violetta*, or little *viol*, is in reality our *triple viol*; though ſtrangers frequently confound the term, with what we have ſaid of the *viola prima*, *ſecunda*, *terza*, &c.

The TRUMPET MARINE is a muſical inſtrument, conſiſting of three tables, which form its triangular body. It has a very long neck with one ſingle ſtring, very thick, mounted on a bridge, which is firm on one ſide, but tremulous on the other. It is ſtruck by a bow with one hand, and with the other the ſtring is preſſed or ſtopped on the neck by the thumb.

It is the trembling of the bridge, when ſtruck, that makes it imitate the ſound of a trumpet; which it does to that perfection, that it is ſcarce poſſible to diſtinguiſh the one from the other. And this is what has given it the denomination of *trumpet marine*, tho' in propriety it be a kind of monochord.

The third kind of *inſtruments* of the firſt claſs, are thoſe made to ſound by means of jacks, armed with quills ends, as *harpſichords*, *ſpinnets*, &c.

The HARPSICHORD is a muſical inſtrument of the ſtring kind, played on after the manner of the organ.

The *harpſichord* is furniſhed with a ſet, and ſometimes two ſets of keys. The touching or ſtriking theſe keys, move a kind of little jacks, which move a double row of chords, or ſtrings of braſs or iron ſtretched on the table of the inſtrument over four bridges.

To underſtand well all the notes of the *harpſichord*, and what keys to touch in order to ſound them, it muſt be obſerved, that the four notes above the treble ſtave, are called *in alt*; and thoſe below the baſs ſtave are called *double*; theſe notes are helped by additional lines, which are alſo called *ledger-lines*.

Ledger-line is that, which when the aſcending and deſcending notes run very high, or very low, is added to the ſtave of five lines; there are ſometimes many of theſe lines both above and below the ſtave, to the number of four or five.

Beſides the two cleffs abovementioned, there is alſo another, called the *tenor-cleff*, which is uſed when the baſs goes high, to avoid *ledger-lines*: this cleff is generally placed on any of the four lower lines, and ſometimes on the fifth, and is always the middle C *fa ut*, of the inſtrument.

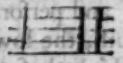
It muſt alſo be obſerved, that in the gamut there are 29 white keys (which is the number contained in many harpſichords, except thoſe made here of late years; to which they add, both above and below, ſometimes to the number of 37) there are alſo 20 black keys, ſomewhat ſhorter than the white ones, which are placed between them, and ſerve for flats and ſharps, ♭♭, and ♯♯.

If any note therefore has a ſharp before it, the inward or ſhort key above it, muſt be touched; and if there be a flat before it, the inward key below it, and ſo on with all the inward keys, which are flats to the plain keys above them, and ſharps to thoſe below them. Between B and C, and between E and F, there are no inward keys as there are between the others, by reaſon they have an interval but of a ſemi-tone between them.

As to the notes and characters in *muſick*, there are firſt the notes called the *ſemi-breve*, *minim*, *crotchet*, *quaver*, *ſemi-quaver*, and *demi-ſemi-quaver*. Next are the characters which are of ſharp, flat, and natural.

Next are the reſts or pauſes, being thoſe uſed to denote ſilence, and are of different lengths; as the *ſemi-breve-reſt*, *minim-reſt*, *crotchet-reſt*, *quaver-reſt*, *ſemi-quaver-reſt*, and *demi-ſemi-quaver*.

There are yet other characters uſed in *muſick*, ſuch as direct, which are uſually ſet at the end of a ſtave, to direct to the place of the next ſtave; as W W W.

There are alſo two ſorts of bars, *viz.* ſingle and double; the firſt ſerves to divide the time according to its meaſure, whether common, or triple; the double bars are ſet to divide the ſtrains of ſongs or tunes; thus 

A repeat which is thus : *S* : is uſed to ſignify that ſuch a part of a tune muſt be played over again; from the note it is placed over. It is alſo marked thus : || :

Common chords are to be played on any note, wherein no figure is put, except when you play in a ſharp key; the 3d and 7th above the key, then naturally require a 6th; but if you play in a flat key, then a 6th is required to the 2d and 7th above the key, unleſs otherwiſe marked.

All keys are either flat or ſharp, not by what flats or ſharps are ſet at the beginning of the tune, but by the third above the key. A ♭ ſet over any note, ſhews that it is to have a flat third; and a ♯ ſharp one, if there be no figure with it.

The

The SPINET is a muſical inſtrument, and is played by two ranges of continued keys; the foremoſt range being the order of the diatonick ſcale, and that behind, the order of the artificial notes or ſemi-tones.

The keys are ſo many long flat pieces of wood, which touched and preſſed down at the end, make the other raiſe jacks, which ſtrike the wire, and cauſe the ſounds, by means of the end of a crow's quill, wherewith 'tis armed.

The figure of the *ſpinet* is a long ſquare, or parallelogram; ſome call it the harp couched; and the harp an inverted *ſpinet*: and the ſame rules ſerve to play on one, as on the other.

In the *ſecond claſs* of inſtruments, are thoſe which are made to ſound by the wind, and that either natural from the mouth, as *flutes*, *trumpets*, *hautboys*, *baſſoons*, *ſackbuts*, *horns*, &c. or artificial by means of bellows, as the *bagpipe*, and that which by way of excellence is called the *organ*.

The FLUTE is an inſtrument of muſick, the ſimpleſt of all thoſe of the wind kind. It is played on by blowing in it with the mouth, and the tones or notes are changed by ſtopping and opening the holes, diſpoſed for that purpoſe along its ſide.

There are two ſorts of *flutes*, viz. the *common flute*, and the *German flute*.

The *common flute* is long like a *lamprey*, and has holes along it, like that fiſh.

The GERMAN FLUTE is an inſtrument entirely different from the *common flute*; it is not like that put into the mouth to be played, but the end is ſtopp'd with a tampion or plug, and the lower lip is applied to a hole about two inches and a half, or three inches diſtant from the end, and about half an inch diſtant from the hole. It is uſually a foot and a half long, rather bigger at the upper end than at the lower, and perforated with holes, beſides that for the mouth, the loweſt of which is ſtopp'd, and opened by the little finger's preſſing on a braſs, or ſometimes a ſilver key, like thoſe on *hautboys*, *baſſoons*, &c. Its ſound is exceeding ſweet and agreeable, and it ſerves as a treble in a concert.

The TRUMPET, from the *Italian tromba*, or *trombetta*, is a muſical inſtrument, the loudeſt of all portable ones of the wind-kind, uſed chiefly in war among the cavalry, to direct them in the ſervice. It is uſually made of braſs, often of ſilver, ſometimes of iron or tin. Its extent is not ſtrictly determinable, ſince it reaches as high as the ſtrength of the breath can force it. A good breath will carry it beyond four octaves, which is the uſual limit of the keys of the ſpinet and organ.

There are people, who blow the *trumpet* ſo ſoftly, and draw ſo delicate a ſound from it, that it is uſed not only in church muſick, but even in chamber muſick.

The HAUTBOY is ſhaped much like the flute, only that it ſpreads or widens towards the bottom. The treble is two feet long, the tenor goes a fifth lower when blown open; it has only eight holes; the baſs is five feet long, and has eleven holes.

This inſtrument is thus held: place the left-hand uppermoſt next your mouth, and the right-hand below; and the contrary with left-handed people; and there are eight holes on this inſtrument, two of which are under braſs keys, nevertheleſs ſeven fingers will be ſufficient to ſupply them; as for example.

Let the fore finger of the left-hand cover the firſt hole, the ſecond on the ſecond hole, and the third on the next hole, which is a double one. In like manner the fore-finger of the right-hand muſt ſtop the next hole, which is alſo a double one, then place the ſecond of the ſame hand on the next hole, then the third finger on the loweſt hole in view, and the little-finger will command the two braſs keys to open one hole, or ſhut the other, which is always open; the double holes ſerve for ſemitones.

Thus all the holes of the pipe being ſtopped, blow ſomewhat ſtrong, and it will ſound diſtinctly the note C *fa ut*, which is the loweſt note on the *hautboy*.

The BASSOON is a muſical inſtrument of the wind kind, ſerving as a baſs in concerts of wind muſick, as of *flutes*, *hautboys*, &c. to make it portable. It is divided into two parts; its diameter at bottom was formerly nine inches, at preſent 'tis but four at moſt, and its holes are ſtopped with keys, &c. like large flutes.

The SACKBUT is a muſical inſtrument of the wind kind, being a kind of a trumpet, though different from the common trumpet, both in form and ſize.

It takes aſunder into four pieces, or branches, and has frequently a wreath in the middle; which is the ſame tube, only twiſted twice, or making two circles in the middle of the inſtrument; by which means it is brought down one fourth lower than its natural tone. It has alſo two pieces or branches on the inſide, which do not appear, except when drawn out by means of an iron bar, and which lengthens it to the degree requiſite to hit the tone required.

The *ſackbut* is uſually eight feet long, without being drawn out, or without reckoning the circles:

when extended to its full length, it is uſually 15 feet, the wreath is two feet nine inches in circumference: it ſerves as baſs in all concerts of wind Muſick.

The Horn is a ſort of muſical inſtrument of the wind kind, chiefly uſed in hunting, to animate the hunters and the dogs, and to call the latter together. The *horn* may have all the extent of the trumpet.

The term was antiently *to wind a horn*, all horns being in thoſe times compaſſed; but ſince ſtrait *horns* are come into faſhion, they ſay *blow a horn*, or *ſound a horn*.

The French Horn, called in *France*, *corne de chaſſe*, is bent into a circle, and goes two or three times round, growing gradually bigger and wider towards the end, which in ſome *horns* is nine or ten inches over.

To play on it, the firſt thing is to conſider the thickneſs or thinneſs of the lips, and provide a mouth-piece accordingly; if they are thick, a pretty broad mouth-piece is required, but if thin, the piece muſt be ſomething ſmaller. Some *Muſicians* have brought the *French horn* to that perfection, and ſound it ſo ſweetly, that of late years it has been introduced into the orcheſtra, among the other inſtruments.

The laſt kind of inſtruments of the ſecond claſs, which are thoſe made to ſound by means of bellows, are the *bagpipe* and the *organ*.

The Bagpipe is a muſical inſtrument of the wind kind, chiefly uſed in country places. It conſiſts of two parts; the firſt is a leather bag, which is blown like a foot-ball by means of a provent, or little tube fixed to it, and ſtopped by a valve. The other part conſiſts of three pipes or flutes, the firſt is called the great pipe or drone, the ſecond the little one, which paſſes the wind out only at bottom, and the third as a tongue, and is played by compreſſing the bag when full, under the arm, and opening and ſtopping the holes, which are eight, with the fingers. The little pipe is ordinarily a foot long, that played on, thirteen inches, and the provent ſix. This inſtrument takes in the compaſs of three octaves.

The Organ is the largeſt and moſt harmonious of all wind inſtruments, chiefly uſed for playing a thorough baſs, with all its accompaniments.

The *organ* is an aſſemblage of ſeveral rows of pipes; its ſize is uſually expreſſed by the length of its largeſt pipe: thus we ſay an *organ* of 32 feet, of 16 feet, of 8 feet, and of 2 feet.

The *organ* has at leaſt one ſet of keys, when it has only one body, and two or three when it has a *poſitive*. The large *organs* have four, ſometimes five ſets; beſides, the pedals or largeſt pipes have their keys, the ſtops or touches whereof are played by the feet.

The keys of an *organ* are uſually divided into four octaves, *viz.* the ſecond ſub-octave, firſt ſub-octave, middle octave, and firſt octave. Each octave is divided into twelve ſtops or frets, whereof the ſeven black mark the natural ſounds, and the five white the artificial ſounds, *i. e.* the flats and ſharps; ſo that the keys uſually contain 48 ſtops or touches. Some organiſts add to this number one or more ſtops in the third ſub-octave, as well as in the ſecond. The pedals extend to two or three octaves, at the pleaſure of the organiſt, ſo that the number or ſtops is undeterminate.

Each key or ſtop preſſed down opens a valve or plug, which correſponds lengthwiſe to as many holes as there are rows of pipes in the ſound-boards. The holes of each row are opened, and ſhut by a regiſter or ruler pierced with 48 holes: by drawing the regiſter, the holes of one row are opened, becauſe the holes of the regiſter correſpond to thoſe of the ſound-board: ſo that by opening a valve, the wind brought into the ſound-board by a large pair of bellows, finds a paſſage into the pipe, which correſponds to the open holes of the ſound-board; but by puſhing the regiſter, the 48 holes of the regiſter not anſwering to any of thoſe of the ſound-board, that row of pipes anſwering to the puſhed regiſter, are ſhut. Whence it follows, that by drawing ſeveral regiſters, ſeveral rows of pipes are opened; and the ſame thing happens, if the ſame regiſter correſponds to ſeveral rows. Hence the rows of pipes become either ſimple or compound; *ſimple*, when only one row anſwers to one regiſter; *compound*, where ſeveral. The organiſts ſay, a row is compound, when ſeveral pipes play upon the preſſing one ſtop.

The pipes of the *organ* are of two kinds, the one with mouths like our flutes, and the other with reeds: the firſt called pipes of mutation, conſiſts,

1. Of a foot, AABB (*Fig.* 15. in the *miſcellanous Plate*) which is a hollow cone, and which receives the wind that is to ſound the pipe.

2. To this foot is faſtened the body of the pipe, BBD, between the foot and the body of the pipe is a diaphragm or partition EEF, which has a little, long, narrow aperture to let out the wind. Over this aperture is the mouth BBCC, whoſe upper lip CC, being level, cuts the wind as it comes out at the aperture.

The pipes are of pewter, lead mixed with a twelfth part of tin, and of wood; thoſe of tin are always open at their extremities; their diameter is very

very ſmall, their ſound is very clear and ſhrill. Thoſe of lead mixed are larger; the ſhorteſt open, the longeſt quite ſtopped, the mean ones partly ſtopped, and having beſides a little ear on each ſide of the mouth, to be drawn cloſer, or ſet further aſunder in order to raiſe or lower the ſound. The wooden pipes are made ſquare, and their extremities ſtopped with a valve or tampion of leather. The ſound of the wooden and leaden pipes are very ſoft; the large ones ſtopped are uſually of wood, the ſmall ones of lead, the longeſt pipes give the graveſt ſound, and the ſhorteſt the moſt acute; their length and width are made in the reciprocal ratio's of their ſounds, and the diviſions regulated by their rule, which they call the diapaſon: but the pipes that are ſhut have the length of thoſe that are open, and which yield the ſame ſound; uſually the longeſt pipe is ſixteen feet, though in extraordinary *organs* 'tis thirty-two; the pedal tubes are always open, though made of wood and of lead.

A reed-pipe conſiſts of a foot, A A B B, (*tab. miſcell. Fig.* 16) which carries the wind into the ſhalot, or reed C D, which is a hollow demi-cylinder, fitted at its extremity D, into a kind of mould I I, by a wooden tampion F G. The ſhalot is covered with a plate of copper E E F F, fitted at its extremity F F, into the mould by the ſame wooden tampion; its other extremity E E is at liberty; ſo that the air entring the ſhalot, makes it tremble or ſhake againſt the reed; and the longer that part of the tongue which is at liberty F L, is made, the deeper is the ſound. The mould I I which ſerves to fix the ſhalot or reed, the tongue, tampion, *&c.* ſerves alſo to ſtop the foot of the pipe, and to oblige the wind to go out wholly at the reed. Laſtly, in the mould is ſoldered the part H H K K, called the tube, whoſe inward opening is a continuation of that of the reed. The form of this tube is different in the different ranks of pipes.

The degree of acuteneſs and gravity in the ſound of a reed-pipe, depends on the length of the tongue, and the tube; and alſo on the thickneſs of the tongue, the figure of the tube, and the quantity of wind.

To diverſify the ſounds of the pipes, they add a valve to the port-vent, which lets the wind go in fits or ſhakes.

The *laſt claſs* of inſtruments, we call *inſtruments of percuſſion*, becauſe made to ſound either with the hand, as *drums*, *tabors*, *tymbals*, &c. or with little ſticks, or ſmall iron rods, as *pſaltery* and *cymbal*; or with a feather, as the *ſyſtrum* and *dulcimer*; or by ſtriking them with hammers, as bells, *&c.*

The DRUM is a military muſical inſtrument, of the pulſatile kind, uſed principally among ſoldiers, to direct their march, attack, retreat, *&c.*

The body of the *drum* is of very thin oak, bent into a cylinder, and covered with parchment, which is ſtrained or braced more or leſs, according to the height or depth of the tone required, by ſtrings, and ſtruck with ſticks.

There are divers beats of the *drum*, as the *march*, *double march*, *aſſemblie*, *charge*, *retreat*, *chamade*, &c.

The TYMBAL, which among the antients conſiſted of a thin piece of leather or ſkin, ſtretched on a circle of wood or iron, and beat with the hand.

This may by our kettle-drum, as it appears to be from the *Italians* uſing the word *tympano* for a pair of *tymbals*.

The KETTLE-DRUMS have their body of braſs, and are uſed among the horſe to be play'd on, with two little iron bars with balls at the end; their ſound is ſofter, and more agreeable than that of the common drum; and they are often uſed in opera's, oratorio's, tragedies, and concerts.

PSALTERION, *pſaltery*, is a muſical inſtrument, much in uſe among the antient *Hebrews*, who called it *nebel*. We know little or nothing of the preciſe form of the antient *pſaltery*.

That now in uſe is a flat inſtrument in form of a *trapezium*, or triangle truncated a-top.

The DULCIMER is a muſical inſtrument, with wire ſtrings, in a triangular form, ſtrung with about fifty ſtrings, caſt over a bridge at each end, and the acuter gradually the ſhorter, the ſhorteſt about eighteen inches, and the longeſt about thirty-ſix, ſtuck with little iron rods: the baſs ſtrings are doubled, and its ſound is not diſagreable: to be plaid on, 'tis laid on a table before the performer, who with a little iron rod in each hand, ſtrikes the ſtrings. This inſtrument is not much uſed except among puppet ſhews.

The muſick of the inſtruments is moſt commonly called *ſymphony*.

The *ſymphony*, or *inſtrumental Muſick*, makes alſo one of the moſt eſſential parts in a concert, opera, oratorio, cantata, *&c.*

A CONCERT, popularly called *conſort*, is a number or company of muſicians playing or ſinging, the ſame piece or ſong at the ſame time.

A *concert* for any inſtrument, as organ, harpſichord, violin, *&c.* is a piece of Muſick wherein either of theſe inſtruments has the greateſt part, or in which the performance is partly alone, and partly accompanied by the other parts.

A CAN-

A CANTATA is a song, or composition, intermixed with recitatives, little airs, and different motions, and merrily intended for a single voice, with a thorough bass, though sometimes for two violins, and other instruments. When the words or subjects are intended for the church, it is called *cantata morali ô spirituali:* but when on love, *cantata amorose*, &c.

OPERA is a dramatick composition, set to Musick and sung on a stage, accompanied with musical instruments, and enriched with magnificent dressings, machines, and other decorations.

ORATORIO is a sort of spiritual opera, full of dialogues, recitativo's, duetto's, trio's, rittornello's, chorus's, &c. the subject whereof is usually taken from the Scripture, or is the life and actions of some saint, &c.

A piece of *Musick* or composition, wholly to be executed by instruments, is called SONATA, by the *Italians*, *suonata*, from *suono*, sound. This is with regard to instruments of several kinds, what *cantata* is with regard to the voice.

MYTHOLOGY.

MYTHOLOGY, MYΘOΛOΓIA, (from μυθος, *fabula*; and λογος, *sermo*, *discourse*) is the history of the fabulous gods, and heroes of antiquity; with the explication of the mysteries, or allegories, couched therein.

The first false divinity adored when men began to abandon the worship of the true God, was the sun: nature seeming to depend entirely for its preservation, on its periodical course and influenence, prompted them to believe that the world was created by it.

But as the true ideas of a Creator were effaced, men at last crowded heaven and earth with as many divinities as they could imagine. The earth itself was deified for furnishing fruits necessary for the subsistence of men and animals; then fire and water became objects of divine worship for their usefulness to human life.

When things were thus got in the train, gods by degrees became multiplied to infinity, and scarce any thing but what the weakness or caprice of some devotee or other, elevated into that rank, things useless, or destructive not excepted.

To authorize their own crimes, and justify their vices and debaucheries, men constituted criminal, vitious, and licentious *gods*, unjust, rapacious, and tyrannical *gods*, covetous and thievish *gods*, drunken *gods*, impudent *gods*, cruel and bloody *gods*.

The principal of the antient gods, were *Jupiter*, *Juno*, *Vesta*, *Minerva*, *Ceres*, *Diana*, *Venus*, *Mars*, *Mercury*, *Neptune*, *Vulcan*, *Apollo*.

Jupiter was considered as god of heaven; *Neptune*, as god of the sea; *Mars*, as god of the war; *Apollo*, of eloquence, poetry, and physick; *Mercury*, of thieves; *Bacchus*, of wine; *Cupid*, of love *Juno* was the goddess of the air; *Diana*, the goddess of woods and chastity; *Proserpine*, the goddess of hell; *Venus*, of beauty; *Thetis*, of the sea, &c.

A second sort of *gods*, called *semi-gods*, *indigetes*, or *gods adopted*, were men canonized and deified. As the greater gods had possession of heaven by their own right, these secondary deities had it by right of donation, being translated into heaven, for that they had lived as *gods* upon earth. Somewhat of this kind is retained in the *Romish canonization of saints*.

The heathen *gods* may all be reduced to the following classes, 1. Created spirits, angels, or dæmons; whence good and evil gods, *genii*, *lares*, *lemures*, *guardian gods*, *infernal gods*, &c.

The *genius* was supposed by the heathens a good or evil spirit or dæmon, set over each person to direct his birth, accompany him in life, and to be his guardian angel.

The antients had their *genii* of nations, of cities, of provinces, &c. Nothing is more common than this following inscription on medals, GENIUS POPULI ROMANI. *The Genius of the* Roman *People*; or, GENIO POP. ROM. *To the Genius of the* Roman *People*.

In this sense *genius* and *lar* were the same thing.

The *Platonists* and eastern Philosophers, supposed the *genii* to inhabit the vast region or extent of air between earth and heaven. They were a sort of intermediate powers, who did the office of mediators between the gods and men. They were the interpreters and agents of the gods; communicated the wills of the deities to men; and the prayers and vows of men to the gods. Most of the Philosophers held, that the *genii* of particular men were born with them, and died: *Plutarch* attributes the ceasing of the oracles to the death of the *genii*.

There were also evil *genii*, who took a pleasure in persecuting men, and bringing them evil tidings; such was that in *Paterculus*, &c. which appeared

to

to *Brutus* the night before the battle of *Philippi*. These were also called *Larvæ* and *Lemures*.

LARES were a kind of domestick *genii*, or divinities, worshiped in houses, and esteemed the guardians and protectors of families; supposed to reside more immediately in the chimney-corner.

Plutarch distinguished good and evil *lares*, as he had before done good and evil *genii*.

There were also some publick, others private *lares*.

The *publick lares* were also called *compitales*, from *Compitum*, a cross-way; and *viales*, from *Via*, a way, or publick road; as being placed at the meeting of roads, and in the highways, and esteemed the patrons and protectors of travellers.

Their private *lares* took care of particular houses and families: these they also called *præstites*, from *Præsto*.

They gave the name *Urbani*, i. e. *lares* of cities, to those who had cities under their care, and *Hostilii* to those who were to keep their enemies off. There were also *lares* of the country, called *rurales*, as appears by several antique inscriptions.

Tertullian tells us, the custom of worshipping the *lares* arose from this, that they antiently interred their dead in their houses; whence the credulous people took occasion to imagine, their souls continued there also, and proceeded to pay them divine honours.

The victim offered to the *lares* in the publick sacrifices was a hog: in private they offered them wine, incense, a crown of wool, and a little of what was left at the table. They also crowned them with flowers, particularly the violet, myrtle, and rosemary. Their symbol was a dog, which which was usually represented by their side, on account of its fidelity, and the service he does to man in watching his house. They were also represented as cloathed in a dog's skin.

The term PENATES, being applied to the domestick gods, whom the antients adored in their houses, was the occasion that the *penates* were ordinarily confounded with the *lares*.

Authors are not at all agreed about the origin of the *dii penates*, who were properly the tutelary gods of the *Trojans*, and were only adopted by the *Romans*, who gave them the title of *Penates*.

The *Penates* were also called sometimes *Denates*.

Dionysius Halicarnasseus, *lib.* 1. speaking of the *dii penates*, tells us, that the historian *Timæus* has wrote, that the statue, figure, or effigy of the *Denates* or *Penates*, was nothing but a crooked iron, or copper rod, and a *Trojan* vessel of potters ware: and that this was all *Æneas* brought from *Troy*.

LEMURES were spirits or hobgoblins; restless ghosts of departed persons, who were supposed to terrify and torment the living.

These are the same with *larvæ*, which the antients imagined to wander round the world to frighten good people, and plague the bad. For which reason at *Rome* they had *lemuria*, or feasts, instituted to appease the *manes* of the deceased.

Of these *lemures*, those that were kind to their families, were called *lares familiares*; but those, who for their crimes were condemed to wander continually, without meeting with any place of rest, and terrified good men, and hurt the bad, were vulgarly called *larvæ*.

The antients used, also, to call the gods abovementioned *indigetes*.——The gods, to whom the *Romans* gave the name *indigetes*, were *Faunus*, *Vesta*, *Æneas*, *Romulus*, all the gods of *Italy*; and at *Athens*, *Minerva*, says *Servius*; at *Carthage*, *Dido*.

The antients called their demi-gods *heroes*, who were illustrious persons of mortal nature; tho' by the populous supposed to partake of immortality; and, after their death, placed by them in the number of the *gods*.

The word *hero* was formed from the *Latin heros*, and that of the *Greek* Ηρως, *semi-deus*, *demi-god*.

The heroes were translated into heaven, by a ceremony called *apotheosis*, from απο and Θεος, *Deus*, *God*.

After the *apotheosis*, which they also called *deification*, and *consecration*, temples, altars, and images, were erected to the new deity; sacrifices, *&c.* were offered, and colleges of priests instituted; and even the senate decreed that oaths should be taken in their names.

Herodian, *lib.* 4. in speaking of the *apotheosis* of *Severus*, gives us a very curious description of the ceremonies used in the *apotheosis* of the *Roman* Emperors. After the body of the deceased Emperor, says he, had been burnt with the usual solemnities, they placed an image of wax, perfectly like him, but of a sickly aspect, on a large bed of ivory, covered with a cloth of gold in the vestibule of the palace. The greatest part of the day the senate sat ranged on the left side of the bed, dressed in robes of mourning; the ladies of the first rank sitting on the right side in plain and white robes, without any ornaments. This lasted for seven days successively, during which, the physicians came from time to time to visit the sick, always making their report that he grew worse, till at length they published that he was dead.

This done, the young senators and *Roman* knights took the bed of state upon their shoulders, carrying it through the *Via Sacra*, to the old forum, where

where the magiſtrates uſed to diveſt themſelves of their offices; there they ſate it down between two kinds of amphitheatres, in the one whereof were the youths, and in the other the maidens of the firſt families of *Rome*, ſinging hymns ſet to ſolemn airs, in praiſe of the deceaſed. Theſe hymns ended, the bed was carried out of the city into the *Campus Martius*, in the middle of which was erected a kind of ſquare pavilion, the inſide whereof was full of combuſtible matters, and the outſide hung with cloth of gold, and adorned with figures of ivory, and various paintings.

Over this edifice were ſeveral others, like the firſt in form and decoration, always diminiſhing and growing ſlenderer towards the top. On the ſecond of theſe was placed the bed of ſtate, and a great quantity of aromates, and odoriferous fruits and herbs were thrown all around; after which the knights made a proceſſion or cavalcade in a ſolemn manner around the pile, ſeveral chariots alſo run round it, thoſe who conducted them being clad in purple robes, and bearing the images of the greateſt *Roman* emperors and generals

This ceremony ended, the new emperor come to the catafalca, or pile, with a torch in his hand; and at the ſame time fire was ſet to it, on all ſides, the ſpices and other combuſtibles, kindling all at once.

While this was doing, they let fly from the top of the building an *eagle*, which mounting into the air with a firebrand, carried the ſoul of the deceaſed emperor along with it into heaven, as the *Romans* believed; and thenceforward he was ranked among the gods.—It is for this reaſon, that the medals, wherein *apotheoſes* are repreſented, have uſually an altar with fire upon it; or an eagle taking its flight into the air, and ſometimes two eagles.

Dæmons are alſo of their firſt claſs of *gods*. By *dæmons Plato* underſtood ſpirits inferior to gods, and yet ſuperior to men; which inhabiting the middle region of the air, kept up the communication between gods and men, carrying the offerings and prayers of men to the gods, and bringing the wills of the gods to men. But he allowed of none but good and beneficent ones; though his diſciples afterwards finding themſelves unable to account for the origin of evil, adopted another ſort of *dæmons* who were enemies to men.

In the *ſecond claſs* of *gods* were the heavenly bodies, as the *ſun*, *moon*, and other planets; the *fixed ſtars*, *conſtellations*, &c.

The Sun was the god of the *Phœnicians*.

The *third claſs* was compoſed of the *elements*, as *air*, *earth*, *ocean*, *Ops*, *Veſta*, the *rivers*, *fountains*, &c.

The antients called the divinities, which they ſuppoſed to inhabit the ſea, *Nereides*, who were fifty in number, all the daughters of *Nereus*, by the nymph *Doris:* and thoſe, who inhabited rivers, fountains, &c. *Naiades*.

The *fourth claſs* contained *meteors:* thus the *Perſians* adored the wind: thunder and lightning were honoured under the name of *Geryon: Caſtor*, *Pollux*, *Helena*, and *Iris*, have alſo been preferred from meteors to be *gods*.

In the *fifth claſs* they erected *minerals*, or *foſſils* into deities; ſuch was the *Bætylus*; the *Finlanders* adored ſtones; the *Scythians* iron; and many nations ſilver and gold.

The *ſixth claſs* conſiſted of *plants:* thus *leeks* and *onions* were deities in *Egypt*. The *Sclavi*, *Lithuanians*, *Celtæ*, *Vandals*, and *Peruvians*, adored trees and foreſts: the antient *Gauls*, *Britons*, *Druids*, bore a particular devotion to the oak; and it was no other than wheat, corn, ſeed, &c. that the antients adored under the names of *Ceres* and *Proſerpina*.

The deities who inhabited the foreſts and trees, were called *Dryades* and *Hamadryades*.

The Dryades were imagined to hide themſelves under the bark of the oak, called by the *Greeks* Δρυς.

The Hamadryades were attached to ſome particular trees with which they were born, and with which they died; whereas the *Dryades* were the Goddeſſes of the trees and woods, and lived at large in the middle thereof.

There was alſo a kind of ſemi-god, called Satyrs, who, with the *fawns* and *ſylvans*, preſided over groves and foreſts, under the direction of *Pan*.

The *ſatyrs* are painted half men, and half goats, the upper part was human, excepting for horns on the head; the lower brutal, with the tail and legs of a goat; the whole covered with hairs.

The poets uſually confound the ſatyrs, ſylvans, ſileni, fawns, and panes.

The Fawns were alſo a ſpecies of demi-gods, inhabiting the foreſts.

The *fauns* are reputed pure *Roman* deities; unknown to the *Greeks*.—They were repreſented, like the *ſatyrs*, half men, half goats, a very flat noſe, and the reſt human.

The *Roman Faunus* was the ſame with the *Greek Pan*.

The *ſeventh claſs* of Gods was taken from among the waters: the *Syrians* and *Egyptians* adored fiſhes; the *Oxyrhinchites*, *Lattopolitani*, *Simnitæ*, and

Plant Chef
Tereck
Plant Taebeer
Bidmush Flowers and Leaves
Plant Terebintes
Wild Spanish Wheat
Flower
Goel
Nazranie
Unknown Plant
Maes
Taka

Taka

Blimy-bing Tree

Citron of China

Cocoas Tree

Nam-Noun Tree

The Bird Paes-Telek

Bird Babbe

Spar found in Lead-Mines

Putrify'd Cockle

One of the Echini Putrify'd

The Fish Sjir-ma-jie

a Glassopetra

Bufonites or Toad Stone

a Glassopetra

Putrify'd Oyster

R. Cole sculp.

and inhabitants of *Elephantis* had each a fish for their god; and the *Tritons*, *Nereides*, *Syrens*, &c. what were they but fishes? several nations have adored serpents, particularly the *Egyptians*, *Prussians*, *Lithuanians*, *Samogitians*, &c.

The TRITON was a *sea semi-god*, held by the antients to be an officer, or trumpeter of *Neptune*, attending on him, and carrying his commands from sea to sea.

The poets and painters, represent him as a half man, and half fish, terminating in a dolphin's tail, and bearing in one hand a sea shell, which served as a trumpet.

But though *Hesiod*, and the *mythologists*, only speak of one *Triton*, the poets have imagined several; giving some of them for trumpeters to all the sea-gods, particularly to *Neptune* and *Venus*.

The *Tritons* not only officiated as trumpeters in *Neptune*'s retinue, but were also supposed to draw his chariot.

The poets ordinarily attribute to *Triton* the office of calming the waves, and of making tempests cease. Thus in the first of the *Metamorphoses* we read, that *Neptune* desiring to recal the waters of the deluge, commanded *Triton* to sound his trumpet, at the noise whereof the waters all retired.

The SIRENS or *mermaids*, are represented by *Ovid* a kind of sea-monster, with women's faces and fishes tails; and by others are decked with a plumage of various colours.

They are supposed to have been the three daughters of the river *Archelous*, and called *Parthenope*, *Ligea*, and *Leucosia*. *Homer* only makes mention of two *Syrens*, but others reckon five. *Claudian* says, they inhabit harmonious rocks, that they were charming monsters; and that sailors were wrecked on their rocks without regret, and even expired in raptures; *dulce malum pelago syren*.

In the *eighth class*, *flies* and *ants* had their priests and votaries; these among the *Thessalians*, and those in *Arcania*; where bullocks were offered to them.

In the *ninth class* among *birds*, the stork, raven, sparhawk, ibis, eagle, griffon, and lapwing, have had divine honours; the last in *Mexico*, the rest in *Egypt* and at *Thebes*.

In the *tenth class four footed beasts* have had their altars; as the bull, dog, cat, wolf, baboon, lion, and crocodile, in *Egypt*, and elsewhere; the hog in the island of *Crete*, rats and mice in the *Troas*, and at *Tenedos*; weazels at *Thebes*, and the porcupine throughout all *Zoroaster*'s school.

In the *eleventh class men* were placed among the number of deities, and from *Belus*, or *Baal*, to the *Roman* emperors before *Constantine*, the instances of this kind are innumerable.

In the *twelfth class* not men only, but every thing that relates to men has been also deified; as labour, rest, sleep, youth, age, death, virtues, vices, occasion, time, place, numbers, and among the *Pythagoreans*, the generative power, under the name of *Priapus*. Infancy alone had a cloud of deities, as *Vegetanus*, *Levana*, *Rumina*, *Edusa*, *Potina*, *Cuba*, *Cumina*, *Carna*, *Ossilago*, *Statulinus*, *Fabulinus*, &c.

They also adored the *gods*, health, fever, fear, love, pain, indignation, shame, impudence, opinion, renown, prudence, science, art, fidelity, felicity, calumny, liberty, money, war, peace, victory, triumph, *&c.*

Lastly, nature, the universe, or το παν, was reputed a great God.

Hesiod has a poem under the title of Θεογονια, *i. e.* the generation of the gods, wherein he explains their genealogy and descent, sets forth who was the first and principal; who next descended from him, and what issue each had; the whole making a sort of system of heathen theology.

Besides this *popular theology*, each philosopher had his separate system, as may be seen from the *Timæus* of *Plato*, and *Cicero de nat. Deor.*

The heathen divinities had a particular sort of *priests* or ministers of their sacrifices, called *flamens*: and at *Rome* there were as many kinds of *flamens*, as there were gods who had sacrifices offered them: as for *Jupiter*, *Flamen Dialis*; for *Mars*, *Flamen Martialis*; for *Romulus*, or *Quirinus*, *Flamen Quirinalis*, &c. In after times twelve more were added, which made the number of *flamens* fifteen.

They had also their *Flaminæ* or *Flaminicæ*, who were wives of the *Flamens*, or the priestesses of the deities.

The *Flamina* had the same surname with her husband, *Flamina Dialis Martialis*, &c.

NATURAL HISTORY.

NATUAL HISTORY, is a description of the natural products of the earth, water, or air, *v. gr.* beasts, birds, fishes, metals, minerals, and fossils, together with such extraordinary phænomena, as at any time appear in the material world, as meteors, monsters, *&c.*

Most of these things have already been treated of under the heads *botany*, *metals*, *minerals*, &c.

ſo that I ſhall confine this treatiſe to monſtrous, ſcarce and extraordinary animals, plants, &c.

But firſt of *animals* in general.

Animal, in natural hiſtory, is an organized and living body, and endowed with ſenſation, and divided into *rational* and *irrational*.

Man is the *only rational* animal; who is an organical body, informed and directed in all its motions, by a ſpiritual, immortal, impaſſible, undefinite, and unalterable ſubſtance, called *ſoul*.

Philoſophers are not all agreed as to the manner wherein the ſoul reſides in the body. Some will have it *tota in toto*, and *tota in quâlibet parte*, *i. e.* diffuſed throughout all the parts of the organical body, which it influences alike, without any particular part, being appropriated to its chief reſidence; others will have it fixed in its center, like the *ſun*, from whence it influences all the inferior parts, like as that planet does all the ſublunary things.

Tho' the *ſoul* is indiviſible, it has ſeveral faculties, the principal whereof are the *underſtanding* and the *will*.

The Understanding, according to the *Peripateticks*, is a faculty of a reaſonable ſoul, converſant about intelligible things, conſidered as intelligible.

Nihil eſt in intellectu quod prius non fuerit in ſenſu, nothing is in the *underſtanding*, which has not been firſt the object of our ſenſes, is the favourite axiom of our modern philoſophers; who thereby attribute two offices to the *underſtanding*, *viz.* perception and judgment.

Will is uſually defined a faculty of the mind, whereby it embraces or rejects any thing repreſented to it, as good or evil, by the judgment.

Mr. *Locke* defines the *will*, a faculty which the ſoul has of beginning or forbearing, continuing or ending ſeveral actions of the mind, and motions of the body, barely by a thought or preference of the mind, ordering, or as it were, commanding the doing, or not doing, ſuch a particular action.

Memory, *imagination*, *liberty* and *ſenſation*, are alſo faculties of the *ſoul*.

Memory is a faculty whereby the *mind* retains, or recollects the ſimple ideas or images of things we have ſeen, imagined, underſtood, *&c.*

Imagination is a faculty of the *ſoul*, by which it conceives or forms ideas of things by means of impreſſions made on the *animal ſpirits*, aſſigned to that faculty.

Senſation is the act of perceiving external objects by means of the organs of ſenſe.

From the firſt *perception* of the objects, from the ſtrength of our *imagination*, which forms to itſelf *ideas* of thoſe objects, and from the juſt œconomy of our *underſtanding*, which directs thoſe *ideas*, proceeds the reducing them into practice, ſo as to form a judgment of them, which is effected by another faculty of the *ſoul*, in which all the operations of the other faculties come to centre themſelves, which faculty we call Reason.

Chauvin has defined *reaſon*, an innate notion, or *idea*: further diffuſed, and ariſing from a continued attention.

Reaſon is the *maſter-faculty*, (if I may uſe that expreſſion) which gives the finiſhing ſtroke to all the other operations, in order to make them a perfect, and accompliſhed work. From thoſe noble operations reſults that excellent quality which exalts the *ſoul* above all other created beings, and that eſſential difference which diſtinguiſhes *man* from all other *animals*.

Rationality; beſides a reaſonable *ſoul*, which raiſes *man* above all other created beings, he has a ſenſitive one, in common with the other *animals*, which both have a vegetative one in common with the *plants*, not that thoſe *ſouls* are eſſentially and ſubſtantially divided from each other, ſo as the one to be capable of ſubſiſting without the other, for they are indiviſible in the ſame ſubject; but becauſe that very ſame *ſoul*, which is capable of rationality in *man*, is alſo capable of ſenſation and vegetation, though the ſenſitive ſoul in the brutes is not *rational*, nor the vegetative in the plants *ſenſitive*.

The *irrational animals* are ſubdivided into terreſtrial, aquatic, volatile, and amphibious, which are endowed with vegetative and ſenſitive ſoul, by virtue whereof they are enabled to provide for themſelves, know what is good for them, and are determined to preſerve and propagate their ſpecies.

Brutes, beſides their ſenſitive and vegetative *ſoul*, conſiſt alſo, like *men*, of ſolid and firm parts, as fleſh, bones, membranes, *&c.* of fluids, as blood, juices, *&c.* and of fat, which may be reckoned an intermediate kind.

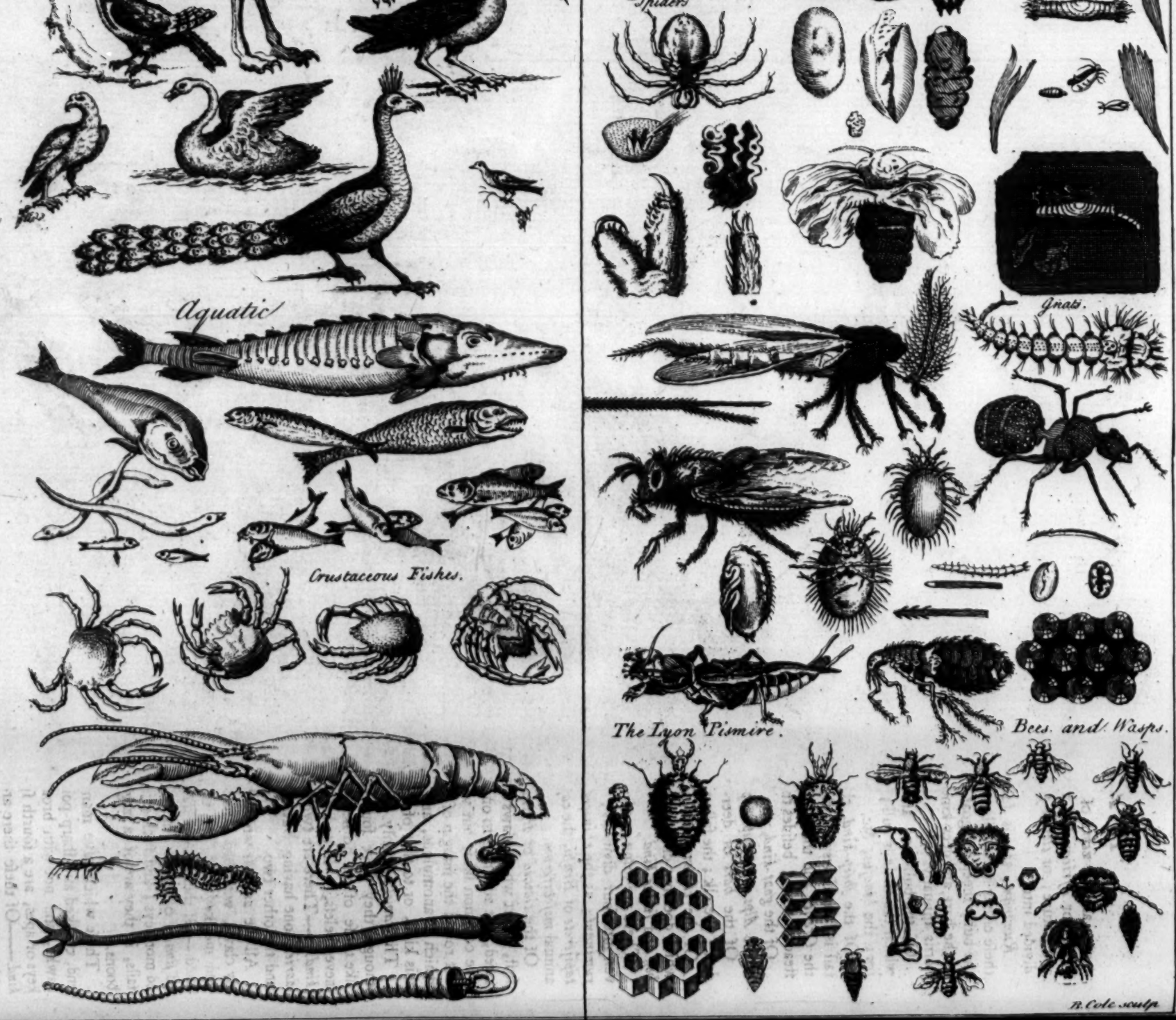
The ſolid parts are mere earth, bound together by ſome oily humour, and accordingly are reducible by fire into ſuch earth again.

Terreſtrial animals, are either *quadrupedes* or *reptiles*.

Quadrupedes are divided by Mr. *Ray*, into thoſe which are *hoofed*, and clawed, or *digitate*.

Hoofed Quadrupedes, are either whole-hoofed, as the horſe, aſs, the *onager* or wild aſs; the mule,

BRUTE ANIMALS *of various* KINDS.


Spiders
Gnats.
Aquatic
Crustaceous Fishes.
The Lyon Pismire.
Bees. and Wasps.
B. Cole sculp.

mule, and the *zebra* of *Africa*, or the fine *ſtriped Indian* or *African* aſs, almoſt like a mule in form and ſtature; or *cloven footed*, and theſe again ſubdivided into,

Ruminant, that is ſuch as chew the cud; and theſe either have hollow and perpetual horns, as the bull, ſheep and goat-kind; or deciduous horns, as the hart and deer-kind, which uſually ſhed their horns annually.

Of the bull-kind are the common bullock, of which the male is bull; the female cow; the *biſon*; the *bonaſus*, &c.

Of the *ſheep-kind*, the *Arabian* ſheep, whoſe tail is ſometimes of forty or fifty pounds weight; the *Cretic*, and the *African*, with ſhort hairs inſtead of wool; beſides the common ſort.

Of the *goat-kind*, the *German* found in the tops of the *Alps*; the *rupi capra*, or *German goms*.

Of the *hart* or deer-kind, the *cervus* or red deer; the elk; the fallow deer; the rain deer, &c.

Of the *cloven footed*, into two parts only, and which does not chew the cud, there's none but a *hog* and *ſwine-kind*.

There are ſome *quadrupedes*, whoſe hoof is cloven into four diviſions; and theſe ſeem to be not *ruminant*; as the *rhinoceros*, the *hippopotamus*; the *tapijerete* of *Braſil*, the *capa bara* of *Braſil*, and the animal *moſchiferum*.

Of the *clawed* or *digitated quadrupedes*, there are firſt, a ſort whoſe claws are not divided or ſeparated, but adhering to one another, covered with one common ſkin, but with obtuſe nails, ſticking out round the margin of the foot; as the *elephant*, which is anomulous, and not clearly referable to this kind, or to that of *cloven-footed quodrupeds*.

The *camel* has only two claws, has no horns, though they have four ſtomachs, and ruminate like thoſe of the horned ruminant-kind, and are nevertheleſs, a ſecond ſpecies of the *digitated-kind*.——There are two ſorts of *camels* or *dromedaries*, one having but one bunch on the back, and the other two.

All the *animals* whoſe foot is divided into many claws, with broad nails on them, as the *ape* and monkey-kind, is a third ſpecies of the ungulated.—Of theſe, ſome have no tails, and are called *ſimiæ*, or apes: others have tails, and are called monkeys; and ſuch as have either long or ſhort tails, if they are of a larger ſize, are called baboons.

Thoſe which have many claws covered at the end, crooked and ſharp-pointed like the talons of hawks, and not with broad flat nails, like monkeys or apes, are a fourth ſpecies of the *ungulated-kind*.——Of theſe there are two ſorts, a greater, which either have a ſhort, round head, as the cat-kind; or a leſſer ſort, having a long, ſlender body, with very ſhort legs, as the weaſel, or vermin-kind.——The hare-kind is a ſpecies of *quadrupedes*, which have only two large remarkable teeth in each jaw, and live upon herbs.

The *lion*, the *tiger*, the *pardus*, the *panther*, the *leopard*, the *lynx*, the *cat a-mountain*, the common *cat*, and the *bear*, are *quadrupedes*, of the cat-kind.

Beſides the common *dog*, of which kind are the *maſtiff*, the *greyhound*, the *Iriſh greyhound*, the *ſpaniel* for land or water, the *tumbler*, the *lap-dog*, the *ſhock*, the *houſe-dog*, &c. &c. The *wolf*, and the *jackall*, are alſo of the *dog-kind*; as well as the *fox*; the *civet cat*, the *badger*, grey or pate, the *otter*, the *ſea calf* or *ſeal*, the *morſe* or *ſea horſe*, the *ſea cow*, &c.

The common *weaſel*, in *Yorkſhire* called *foumart* or *fitcher*, the *quel*, or *quirple*; the *muſtela ermin* or *ſtoat*, if white; the *ferret*, the *pole cat*, the *marten* or *martlet*, the *ſable*, &c. are of the *vermin-kind* of *quadrupedes*.

The common *hare*, the *rabit* or *coney*, the *porcupine*, the *caſtor*, *fiber*, or the *beaver*, the *ſquirrel*, the *Virginian*, *Zelandic*, *Barbary*, and *American flying ſquirrel*, the common *rat* and *mouſe*, the *water rat*, the *muſk rat*, the *dormouſe*, or *ſleeper*, the *guinea pig*, &c. are *quadrupedes* of the *hare kind*.

There are ſix ſorts of anamolous *quadrupedes*, or of *quadrupedes* that deviate from the common form of *animals* of the ſame kind.

1. *Animals* with their feet divided into many claws and toes, have a longiſh ſnout, and teeth; as the *hedge-hog*, the *mole*, the *warp*, or *mole-warp*, *ſhrew*, *hardyſhrew*, *ſhrew-mouſe*, &c.

2. Thoſe with their feet divided, alſo, into many claws and toes, have a longiſh ſnout, but no teeth; as the great *ant-bear*, the leſſer *ant-bear* of *Marcgrave*, the *tamandua-guacu* of *Braſil*, &c.

3. The *bat-kind*, or *flitter-mice*, of which there are ſeveral ſizes and different forms, and which are *anomalous flying quadrupedes*, with a ſhorter ſnout, and their feet divided.

4. The *ſloath* or *ſluggard* is an anomalous *animal*, which has but three claws on each foot.

5. The *frog* or *froſh*, the *ſmall tree* or *green frog*, the *toad*, the *tortoiſe* of land or water, are *viviparous* and *ſanguinous quadrupedes*, breathing with lungs; but have but one ventricle in the heart.

6. The *crocodile*, the common *eft*, *ſwift* or *newt*; the *green lizard*, the *Neopolitan tarantula*, the *ſwift* or *ſpotted lizard*, the *water eft*, and the *cameleon* or *camilion*, are *oviparous quadrupedes*, with a long tail, ſtretched out horizontally.

Reptiles (from the Latin *repo*, I creep) are another ſpecies of *terreſtrial animals*, which inſtead of feet reſt on one part of the body, while they advance forwards with the reſt, as *vipers*, *ſnakes*, *earth worms*, &c.

The Aquatic *animals* are all thoſe that live in water; as fiſhes of all kind.

Fishes are diſtinguiſhed into ſalt water fiſh, *piſces marini*, as the *whale*, *herring*, *mackarel*, *ſole*, *ſkate*, *turbot*, &c. &c. and freſh water fiſh, *piſces fluviatiles*, as the *pike*, *trout*, *carp*, *tench*, &c. to which may be added, *ſalmons*, *ſhad-fiſh*, which abide indifferently in freſh water or ſalt.

M. *Willoughby* diſtinguiſhes fiſhes into *cetaceous*, *cartilaginous* and *ſpinous*.

The Cetaceous (from the Latin *cetus*, *whale*,) have lungs, and breath like *quadrupedes*, copulate like them, conceive and bring forth their young alive, which they afterwards ſuckle with their milk, as the *whale*, the *dolphin*, *phocæna*, the *porpus*, &c.

The *cartilaginous* ſorts (thus called for their having their bones of a cartilaginous ſubſtance) are produced from large eggs, like birds, which are alſo excluded the womb, like thoſe of birds; and theſe are divided into long cartilaginous and plain cartilaginous.

The *long cartilaginous* are the *white ſhark*, the *blue ſhark*, the *tope*, the *prickled-dog*, or *hound-fiſh*, the *ſmooth* or *unprickled hound-fiſh*, the *rough-hound*, or *bounce*, the leſſer *hound-fiſh*, or *morgay*, &c.

The *plain cartilaginous* are the *ſkate* or *ſtare*, the *thorn-back*, the *white horſe*, the *angel*, or *monk-fiſh*, the *toad-fiſh*, or *ſea-devil*, &c.

Spinous Fishes (from their having *ſpinæ* up and down in their fleſh to ſtrengthen it) are alſo *ouiparous*, but their eggs are ſmaller; and theſe are alſo divided into *long ſpinous* and *plain ſpinous*.

The *long ſpinous* are the *eel-kind*, viz. the *lamprey*, or *lamprey-eel*; the *lampern*; the *common-eel*; the *conger*, or *ſea-eel*; the *ſand-eel*, or *launce*; the *butter-fiſh*; the *ſea-loach*, or *whiſtle-fiſh*: the *eel-pout*, or *turbot*; the *wolf-fiſh*, or *ſea-wolf*; the *ſea-lark*, called in *Cornwal*, *mulgranock* and *bulkard*; the creſted *ſea-lark*; the *bull's-head*, or *miller's-thumb*; the *Dutch pot's-hog*; the *Corniſh* boys call it *Father Laſher*.

The *plain ſpinous* are the *turbot* or *brett*; the *lug-aleſe*; the *plaiſe*; the *flounder*, *fluke*, or *butt*; the *holy-butt*; the *ſole*, &c.

There are three different ſorts of the *none-ſpinous* kind of fiſhes; ſome with only one ſoft and prickly fin on their back; ſome with two, and others with three.

Thoſe with only one fin on their back, are the *herring*, the *pilchard*, the *anchovy*, the *ſhad*, the *ſprat* or *ſparling*, which is nothing elſe but the *fœtus* of a *herring*; the *garniſh*, or *horn-fiſh*, the *ſturgeon*, the *pike*, or *pikrel*, the *carp*, the *bream* or *bruma*, the *tench*, the *rudd*, *oerve*, or *nexſling*, the *chubb* or *chevin*, the *barbel*, the *dace* or *dare*, the *rooch*, *bleak* or *bley*, the *gudgeon*, the *loch*, the *pink*, or *minnow*, &c.

Thoſe with two fins on their back, are the *hake*, the *ling*, the *tunny*, or *Spaniſh mackrel*, the *mackrel*, the *grayling* or *umber*, the *guinniad*, the *ſhelly*, the *ſalmon*, the *ſamlet* or *branlin*, the *gray*, the *ſalmon-trout*, the *ſcurf* or *bull-trout*, the *red-chart*, or *Welch torgoch*, the *guilt*, or *guilt charr*, the *ſmelt*, the *rock-fiſh*, or *ſea-gudgeon*, the *lump*, or *ſea-owl*, &c.

Thoſe with three unprickly ſoft fins on their back, are the *cod-fiſh*, or *caling*, the *whiting pollack*, the *coal-fiſh*, or *rawligg pollack*, the *bib*, or *blinds*, the *haddock*, the *whiting*, &c.

There are fiſhes called of the *aculate kind*, with only one fin on their back. whoſe *radii* are ſome prickly and ſome ſoft; ſuch are the *guilt-head*, or *guilt-poll*, the *bream*, the *old-wife*, or *wrap*, the *ruff*, the common *prickle-back*, or *ſharpling*, or *banſtickle*, the leſſer *prickle-back*, &c.

Others with two fins on their back, whoſe *radii* are all prickly, as the *mullet*, the *grey-gurnard*, the *tub-fiſh*, the *red gurnard*, or *rotchet*, the *piper*, the *ſur-mullet*, the *ſpider*, the *ſcad*, the *perch*, the *dory*, or *doree*, &c.

There are alſo *cruſtaceous* and *teſtaceous fiſhes*.

The Crustaceous are thoſe covered with ſhells of ſeveral pieces, or ſcales, as *crabs*, *lobſters*, *craw-fiſhes*, *ſhrimps*, &c.

The Testaceous are thoſe covered with a ſtrong, thick ſhell, as *tortoiſes*, *oyſters*, *pearl-fiſh*, &c.

Amphibious (from the *Greek*, αμφι, *utrumque*, bothways, and βιος, *vita*, life) are a ſort of animals, which live both on land and in the water; *i. e.* which breathe the air, but paſs part of their time in the water, as affording them their chief food.——Such are the *frog*, *caſtor*, *otter*, *tortoiſe*, *ſea-calf*, *crocodile*, &c.

Volatiles are two-footed *animals*, covered with feathers, and furniſhed with wings, whereby they can ſuſtain themſelves in the air, and fly from place to place.

They are divided into terreſtrial, and aquatick *volatiles*.

Terreſtrial volatiles are ſubdivided into thoſe which have *crooked beaks*, and *talons*; and thoſe whoſe *beaks* and *claws* are ſtraiter.

Of thoſe with *crooked beaks* and *talons*, ſome are *carnivorus* and *rapacious*, called *birds of prey*; others *frugivorous*, called by the general name of *parrots*.

Of *birds of prey*, ſome prey in the day-time, called *diurnal*; others in the night, called *nocturnal birds*.

Diurnal birds, are either of a greater, or a leſſer ſize.——The greater are either of a more bold, and generous nature, as the *eagle-kind*; or of a more cowardly and ſluggiſh, as the *vulture*, and *cuntor*.

The leſſer *diurnal birds of prey*, are either of a generous and docible, or cowardly, ſluggiſh, and untractable nature.

The generous and docible are the *hawk-kind*, which are wont to be reclaimed, and managed for fowling.

The *nocturnal birds of prey*, with *crooked beaks*, and *talons*, are the *owl-kind*, and theſe are either horned or eared, as the *eagle-owl*, *horn-owl*, &c. or without horns or ears, as the *brown owl*, *white-owl*, *grey owl*, *howlet*, *fern-owl*, or *goat-ſucker*, &c.

There are three ſizes of the *land birds*, or *terreſtrial volatiles*, with crooked beaks and talons, the greateſt of which are called *macaws*, and *cockatoes*; the middle-ſized, and moſt common *parrots* and *poppinjays*; and the leaſt ſort, *parakeets*: thoſe all make uſe of their beak in climbing, and move the upper jaw.

There are alſo three ſorts of *land birds*, which have their bills and claws more ſtrait; the greateſt thereof are ſuch as by reaſon of the bulk of their bodies, and ſmalneſs of their wings cannot fly at all; ſuch are the *oſtrich*, the *caſſowary*, and the *dodo*.

The middle-ſized are divided into ſuch as have either large and long, or ſmaller and ſhorter bills.

Of thoſe with large, thick, ſtrong and long bills, ſome feed promiſcuouſly on fleſh, inſects and fruits, as the *crow kind*, which are wholly black; and the *pye-kind*, which are party-coloured, as the *magpye*, *jay*, *roller*, &c. others feed on fiſh only, as the *King's-fiſher*; and others on inſects only, as the *wood-pecker*.

For thoſe which have a ſmaller and ſhorter bill, their fleſh is either white, as the poultry-kind, or blackiſh, as the *pidgeon*, and *thruſh-kind*.

The leaſt ſized kind of *land birds*, with ſtrait bills, and claws, are called ſmall birds.——Theſe are of two kinds; ſoft-beaked, which have ſlender, ſtraight, and pretty longiſh bills, moſt of them, and feed chiefly upon inſects; and hard-beaked, which have thick and hard bills, and feed moſtly on ſeed.

AQUATICK VOLATILES or *water fowls*, are diſtinguiſhed into ſuch as walk in the waters, and ſuch as ſwim in them,

Aquaticks, which walk in the water, are all *cloven footed*, and generally have long legs; and thoſe naked, or bare of feathers, a good way above the knee, that they may the more conveniently wade in waters. Of theſe they reckon two kinds; a *greater*, and a *leſſer*.——To the greater belong the *crane*, *jabiru*, &c.——The leſſer are either *piſcovorous*, as the *heron*, *ſpoon-bill*, *ſtork*, &c. or *mudſuckers* and *inſectivorous*, or *inſect-eaters*.

Of *inſectivorous* water-fowl, ſome have very long bills, either crooked, as the *curlieu* and *wimbrel*, or ſtraight, as the *woodcock* and *godwith*; others middle-ſiz'd ones, as the *ſea-pye* and *red-ſhank*; others ſhort bills, as the *lapwing* and *plover*.

Thoſe are reckond ſhort bills, which exceed not an inch and half; middle ſized bills to two inches and a half; and long bills, above two inches and a half.

Of *aquaticks*, which ſwim in the water, ſome are *cloven footed*, as the *moor-hen* and *coot*, &c. but moſt are whole-footed or web-footed.——Of theſe, ſome few have very long legs, but the generality are ſhort legged.

Of the *ſhort legged*, *whole footed aquaticks*, ſome have but three toes on each foot, as the *pinguin*, *razor-bill*, &c. but generally they have four toes on each foot, and theſe either all connected together by intervening membranes, as in the *pelican*, *ſoland gooſe*, &c. or more uſually with the back toe looſe.

This laſt kind are either *narrow billed* or *broad-billed*; thoſe with narrow bills, have them either blunt and hooked at the tip, or ſharp pointed and ſtraighter.

Of the former ſort, ſome are ſerrate, as in the *diver-kind*; and ſome not toothed, as in the *puffing*.

Of thoſe with ſharp pointed and ſtraighter bills, ſome have long wings, as the *gall-kind*, and ſome ſhorter, as thoſe *diving birds*, called *daukers*.

Thoſe with broad bills may be divided into the *gooſe-kind*, which are larger; and the *duck-kind*, which are ſmaller; and theſe latter into *ſea ducks* or river and *plaſh-ducks*.

Moſt water fowls have a ſhort tail, and none of theſe have more than one back toe.

There is alſo another kind of *volatiles*, called *birds of paſſage*; ſuch as the *ſwallow*, *quail*, *ſtork*, *crane*, *fieldfare*, *woodcock*, *nightingale*, &c. Thoſe do not appear in our climates, but at certain ſeaſons, and then diſappear again; but which way they ſteer their courſe, and whither they go, is what puzzles our *Naturaliſts*.

Insects are also a species of terrestrial animals, but smaller than those heretofore mentioned, commonly supposed to be *exsanguineous*, and distinguished by certain incisures, cuttings, or indentings in their bodies.

They are divided by Mr. *Ray* into those that change their form, and those that do not change their form.

Insects which do not change their form, are either with feet, or without feet, and of these some cast their skin, and others do not.

Those without feet are either *land insects*, or *aquatick land insects*, are either produced on the land, or in the bowels of animals.——Those produced on the land, are either of the larger size, as the *dew worms*, or of a smaller sort, of which some are green, and others red with yellow tails, called *gilt-tails*.

Those found in the bowels of animals, particularly in the intestines of men, are the *lumbrici teretes*, and *lumbrici lati*, also called *taniæ*; and *ascarides*, chiefly found in the *rectum*.

The *vermiculi setiformes*, of the thickness of a horse hair, and the *breves*, and *crassiores* or *botts*, are the two sorts found in the intestines of beasts, the latter being oftner discovered in horses than in any of the others.

Aquatick insects, without feet, not changing their form, are either of the greater, or of the lesser sort.—Of those of the greatest sort, some are *tiretes*, round and smooth, of which there are three sorts, the medicinal *hirundines*, or *leaches*, the *common black horse leaches*, and the *ash-colour'd sea-leaches*.

Those of the *lesser sort*, are also either round, or flat: —Of the round sort, one is black with two small horns on its head, found sticking to wet stones in the watry tops of hills; and another red, about a finger's length, with a *forceps* at the tail, found at the bottom of fish-ponds, and stagnant waters.—The flat sort, called *flukes*, are very small and thin, and found sometimes in water, and sometimes in the branches of the *porus bilarius* in sheep. —These have a different way of moving or crawling, from the greater sort.

Insects which do not change form, and have feet, are either with six, eight, fourteen, or many feet.

Those with but six feet, are either *terrestrial*, or *aquatick*.—— Of the *terrestrial* there are two sorts, a larger, and a smaller sort ——Of the larger sort are, the *yellowish insect*, found in rotten decaying oaks; the *black one*, on the ground, called by *Mouffet Vermivorus*, *worms-devourer*; the black one living under ground with a *forceps* at the tail; a *white sort*, with square black spots on its back; the *farinarium*, bred in meal, of a whitish colour.

Of the smaller sort, some are found about the bodies of animals, as the *bug*, or *wall-louse*, of a stinking smell; the *tick*, the *common louse*, the *flea*, the *crab louse*; and others are not found on the bodies of animals; as one found in books and rotten wood, which resembles a louse, both in figure and bigness, though a great deal nimbler and swifter; another with a longer body and a forcipal tail, the *black insect*, found often in the flowers of *chelidonium*, a subterraneous sort, a little whitish, and one that skips like a *grashopper*, but is much less.

The *aquatic* are the *pediculus marinus grandis*, which adheres to fishes; and the *squilla fluviatilis*, with a pyramidal tail, and two hairs or bristles at the end.——

Insects not changing form, and with eight feet, are either with a tail, as the *scarpion*, or without; as first, the *spider*; of which some spin no web, have but two eyes, and very long legs, as the *opilio* or *shepherd*: others spin a web, and of these they count three sorts, 1. The *aranea columstrensis abdomine timido subrotundo, & elato*. 2. The *spider* with the *thorax*, or middle part of its body, as big as the *abdomen*. 3. The *spider* with the long *abdomen*, found among reeds, rushes, grass, &c. Secondly, the *riciniocto pedes*, which are some more flat and compressed; as the *rambling ticks*, that run over the bodies of animals, but do not fasten; and some more round and thick, which do adhere to the skin. Thirdly, the *syrones*, or *mites*.

There are three sorts of *asilli*, or of *insects*, not changing form, and with fourteen feet; as the *sea-asellus*, living among the rocks, which is the longest and largest sort; the *asellus lividus*, which rolls itself up into a ball, the common *wood-lice*, *sows*, or *chest-bugs*; and the *asellus aquaticus*, with a forked tail, not rolling itself up.——To which may be added, the *asellus marinus*, rolling itself up; the *asellus aquarum dulcium*, with long legs, and two bristles on its tail; *pulex aquaticus*, both in fresh and salt water; and the *pediculus aquaticus*, which fastens upon fish.

The Naturalists have observed two kinds of *insects*, not changing form, with four and twenty feet, the eight four-feet lesser, and the sixteen hinder ones larger, and both with long bodies; the larger sort is of an obscure colour, which live among the rocks by the sea side; and the lesser of a silver colour found in houses.

There is also a kind with thirty feet, of an oblong shape, chesnut colour, and full flattish body, usually

uſually lying under logs and trunks of trees; it is very agile and ſwift.

Inſects, not changing form with many feet, called πολυποδα, are ſome on land, and either roundiſh in body, with all their legs riſing out of the middle of their belly, as the *julus*; or more flat and compreſſed, with their legs not riſing as before, from a point in the middle of their body, but growing along on the ſide, as the *ſcolopandra*.

Swammerdam ſhews there is no real transformation in *inſects*, ſuppoſed to undergo a change in their form, but only on explication of the parts of the *animal*, latent before in miniature, like the plant in the ſeed, and an increaſe of the parts by proper degrees.

The *firſt ſpecies* of tranſmutation, or change, is inſtantaneous, *i. e.* there is no ſenſible reſt or ſtop, between the old and the new form.——The *inſects* of this order do not loſe their motion at the time they ſhift the *pellicula*, at leaſt not to appearance.—This is when the *vermiculus*, leaving the former ſhape of the *nympha*, with which it appeared in the egg, and ſubſiſted without food, now begins to feed, has its members or parts viſibly increaſed, or ſtretched out, and takes the form of a new *nympha*, which is not without motion; and from thence becomes a flying inſect.

There are twelve ſorts of theſe *inſects*. 1. The *libellæ*, or *perlæ*, produced from an inſect of ſix feet, which *Mouffet* takes for the *pulex marinus*, through whoſe cruſtaceous ſkin the *libella* breaks by a fiſſure, which begins between the eyes, and is continued to the roots of the wings, and is there joined to the lateral fiſſures. 2. The *cimices ſylveſtres*, whoſe characteriſtick marks (according to *Willoughby*) are, *firſt*, a long *proboſcis*, not ſpiral, but ſtrait; *ſecondly*, their upper wings to the middle are thick and like leather; thence to the end thin, and membranous; *thirdly*, there is the figure of St. *Andrew*'s croſs on their back. 3. The *locuſtæ*. 4. The *gryllii campeſtres*. 5. The *gryllii domeſtici*, or *crickets*. 6. The *mole cricket*. 7. The *graſshopper*. 8. The *blattæ*. 9. The *tipulæ aquaticæ*, which run very ſwiftly on the ſurface of the water, and have a ſting in their mouth like the *cimices* or *ticks*. 10. The *ſcorpius aquaticus*, with a ſting alſo in its mouth. 11. The *muſcæ aquaticæ*, called by *Aldrovandus*, *apes amphibiæ*. 12. The *emerobius*, or *ephemera*, or *diaria* of *Swammerdam*, the *forficula*, or *auricularia*.

The ſecond ſpecies of tranſmutation includes ſuch *inſects* as undergo a double *metamorphoſis*, or change of ſhape. 1. Into a *chryſalis*, or ſomething analogous to it. 2. Into a flying *inſect*. Theſe kinds of *inſects* a-while before they change, lie quite ſtill, without feeding or changing place; and in reſpect of their wings are, *firſt*, *vaginipennia*, as *ſcarabæi*, beetles. *Secondly*, Αναπτερα, whoſe wings are open, and expanded; and the wings of theſe are either farinaceous, as the *papiliones*, &c. or membranous, as the *apes*, *muſcæ*, &c. and theſe are either with two, or with four wings.

The *ſcarabæi* may be divided; 1. With reſpect to their horns into the *naſicornis*, *bucerota*, and *cervus volans*, or *taurus*. 2. In reſpect of their *antennæ*, which are of many kinds; whereof the moſt eminent are thoſe called *capricorni*. 3. With regard to their motion, as the *ſaltatrices*, or dancers. 4. With regard to their colour, as the *cantharides*, or *Spaniſh* flies.

To the *beetle*-kind may alſo be referred the *cicindela*, or *glow-worm*, the *ſtaphylinus*, the *proſcarabæus*, or *oil-beetle*, ſo called, from its emitting from its joints a kind of oil, on its being preſſed or ſqueezed. The *anelytra*, with farinaceous or mealy wings, are called *papiliones*, butterflies; and theſe are either diurnal or nocturnal.

The ſpecifick diſtinction of the diurnal *butterflies*, or *papiliones* is, that they always ſettle with their wings erect, are produced from an *angulous aurelia*, and have their *antennæ* ſtudded; of theſe there are above fifty ſorts obſerved in *England*.

The *nocturnal butterflies*, though very numerous, may nevertheleſs be divided into,

1. The *geometrigenæ*, (thus called, from the manner of its walking with its back curled up like the handle of a cup) which come from an *erucæ*, and has eight or ten feet. 2. Such as come from *erucæ* with fourteen feet; of this kind which is very numerous, there has been diſtinguiſhed the *phalæna faſciata*, whoſe wings are in patches, or *area*'s of different colours; *phalæna lineata*, whoſe wings are marked with one or more points; and theſe, except all the others, are diſtinguiſhed into greater, leſſer, and of a middle ſize between both.—One of the larger kind may be diſtinguiſhed alſo, by their inner wings; and a third by their long tails, and narrow ſharp wings; which by ſome are called *phalænæ prædatrices*.

The *anelytra* with membranous wings are *bees*, *flies*, *waſps*, *bombylii*, *crabrones*, &c. and to this kind the *culex vulgaris*, or *gnat*, according to *Swammerdam*, is referred, as alſo the *formica*, or *ant*.

Willoughby refers alſo to this kind, ſuch water *inſects* as are covered with a *theca*.

The *third ſpecies* of tranſmutation, is a ſimple change from a *vermiculous* to a *flying inſect*; but with a ſenſible reſt or ſtop between one form and the other. This exchange is deſcribed by *Swammerdam* in the following manner.

"The vermicle excluded from the egg (ſays he) gets nouriſhment by little and little from without, and

and under that firſt ſkin or covering, has its members increaſed by degrees; not ſtripping it or putting it off, as other *vermiculi* do, when they change into *nymphæ*, but aſſuming the figure of a *nympha* in it. For a time it is quite motionleſs, 'till the ſuperfluous moiſture is evaporated, and then, in a few days recovers its motion again, and caſting off this ſkin, which is, as it were, double, it becomes a fly."—Of this kind are our *fleſh-flies*, and all the *nymphæ vermiformes*, the *veſpæ ichneumones*, &c.

The Silk-worm is an inſect, not more remarkable for the precious matter it furniſhes for divers ſtuffs, than for the many forms it aſſumes, before, and after its being invelloped in the rich cod, or ball it weaves itſelf. From a ſmall egg, about the ſize of a pin's head, which is its firſt ſtate, it becomes a pretty big worm or maggot, of a whitiſh colour, inclining to yellow.—In this ſtate it feeds on mulberry-leaves, till being come to maturity, it winds itſelf up into a ſilken bag or caſe, about the ſize and ſhape of a pigeon's egg; and becomes metamorphoſed into an *aurelia*: in this ſtate it remains without any ſign of life or motion; tho' it caſts a life, by which it prepares itſelf for a new life, and then dies, which egg wants no other incubation, than the warmth of the ſummer-weather, or of ſome other gradual heat.

As ſoon as the *ſilk-worm* is arrived at the ſize and ſtrength, neceſſary for beginning its cod, he makes his web; for thus they call that ſlight tiſſue, which is the beginning and ground of that admirble work.—This is his firſt day's employment. On the ſecond, he forms his *folliculus*, or ball, and covers himſelf almoſt over with ſilk. The third day he is quite hid; and the following days employs himſelf in thickening and ſtrengthening his ball, always working from one ſingle end, which he never breaks by his own fault, and which is ſo fine and ſo long, that thoſe who have examined it attentively, think they ſpeak within compaſs, when they affirm that each ball contains ſilk enough to reach the length of ſix *Engliſh* miles.

In ten days time the ball is in its perfection; and is now to be taken down from the branches of the mulberry-tree, where the worms have hung it.

The Tarantula is about the ſize of an acorn, and has eight feet, and as many eyes; its colour various, but it is ſtill hairy: from its mouth ariſes two horns, or trunks, made a little crooked, with tips exceedingly ſharp, through which it conveys its poiſon.

The Cochineal *worm* is an inſect ingendered in a fruit reſembling a pear, the ſhrub which bears it is five or ſix foot high. A-top of the fruit grows a red flower, which, when mature, falls off the fruit; and that opening diſcovers a cleft two or three inches in diameter. The fruit then appears full of little red *inſects*, having wings of a ſurpriſing ſmallneſs, and which would continue and die, and rot there if not taken out.

The *Indians* therefore ſpreading a cloth under the tree, ſhake it with poles, 'till the *inſects* are forced to quit their lodging and fly about the tree, which they cannot do long, but tumble down dead in the cloth; where they are left 'till they be entirely dry: when the *inſect* flies it is red, when it is fallen, black, and when dry, white; though it afterwards changes colour.

Some of the *inſects* are rather more perfect than the greateſt part of the other *animals*, as it plainly appears by the government of Bees, who, in their perfect union, the beauty and juſt œconomy of their government, their reſpect for their prince, and the ſubordination ſubſiſting among them, ſeem to rival the beſt eſtabliſhed commonwealth. — They all work in common, and all in common reap the fruits of their induſtry and daily labour, which they divide among them, ſome keeping within the precinct of their walls or hives, to lay up the ſtores, which the others deſigned for the queſt, bring to the common ſtock.—Theſe lay down the foundations of new manſions, and thoſe adorn them when built with that precious and rich furniture, which the maroders, who take the fields have gathered from the purple of the violets, the ſcarlet of roſes, and other inimitable and beautiful ſhades, which the inimitable artiſt, *nature*, has painted on the flowers, wherewith our fields are enamelled during the moſt favourable ſeaſons of the year.—Some are placed at the gates of the metropolis, or as advanced guards, to give the alarm at the approaches of their common enemy, the *waſp*, and hinder him from inſulting their walls; or, as aſtronomers, to obſerve the changes of the heavens, and foretel the approaches of rain and tempeſts, or to eaſe thoſe, who return home over-burthened with their booty; who all ſet out in the morning on their different occupations, leaving the care of the *hive* to thoſe, who are paſt labour, and return as well to have the pleaſure to take a meal in common, as to reſt themſelves from their fatigues; to which they are called by thoſe left within, ſounding the retreat, at which they all retire within their walls, with ſuch unanimous conſent, and quick obedience, that it is impoſſible to find, after the time fixed for that retreat, any ſtrollers upon the road.—At night they are all wrapped up in ſo profound a ſleep, that there is not the leaſt noiſe, or diſturbance heard in their little garriſons.

Though

Though the life of the *bee* is but of a ſhort duration, and ſeldom exceeding ſeven years, they nevertheleſs have very numerous families, and have the pleaſure to have been bleſſed before they die with a long poſterity, which they have the ſatisfaction to leave behind them in a flouriſhing condition, ſeldom departing before they have ſeen ſeveral generations.

No nation has ever been, or will ever be more dutiful to a ſovereign than the *bees* are to theirs; for they have really a king, who is abſolute maſter, not of their deſtiny only, but alſo of all their faculties, whom they obey, without the leaſt reluctancy, in all he is pleaſed to command them.—He is the guardian of their work; they admire none but him, and all tremble at his ſingle aſpect.—They are all his *body-guard*; and often carry him upon their ſhoulders, ſeldom being ambitious of any other glory, but that of loſing their lives in his fight, and in his defence; for the *bees* do not live always in the ſame profound peace, as there are ſeveral nations of them, each governed by its own king; there often ariſe diſputes, jarrs, and differences between them, which ſometimes are not to be otherwiſe terminated but upon the field of battle, and then the king, who never entruſts a general with the command of his army, but alway heads them in perſon, has the ſatisfaction to ſee his ſoldiers endeavour to outvie each other in courage, valour, and intrepidity; for as ſoon as the onſet is given, they all gather round him, as if they would make him a rampart of their bodies, and fight with that diſcipline and order, which would be admired among men; the conqueror keeping the field of battle, after he has defeated his enemy, in ſign of his victory, and both parties taking care of their dead, wounded, *&c.*

MONSTER is a birth, or production of a living thing, degenerating from the proper and uſeful diſpoſition of parts, in the ſpecies it belongs to.

Monſters do not propagate their kind, for which reaſon ſome rank *mules* among the number of *monſters*, as alſo *hermaphrodites*.

A *mule* is uſually generated between an aſs and a mare, ſometimes alſo between a horſe and a ſhe aſs.

An *hermaphrodite* is a perſon, who has both ſexes, or the genital parts, both of male and female.

The word is formed of the *Greek* Ερμαφροδιτος, a compound of Ερμης, *Mercury*, and Αφροδιτη, *Venus*, a mixture of *Mercury* and *Venus*, i. e. of male and female.

Naturaliſts diſtinguiſh four kinds of *hermaphrodites*, whereof the laſt are the perfect *hermaphrodites*, or thoſe, who have the *pudenda* of both kinds; but theſe are rarely, if ever, found.

Hermaphrodite is alſo applied metaphorically to divers other things beſides the human ſpecies.

Such are the earth-worms, the round-tail worms found in the inteſtines of men and horſes, land-ſnails, and thoſe of freſh waters, and all the ſorts of leaches.

The moſt monſtrous productions in the vegetable world are called *mules*, which are monſters produced by putting the furina fæcundans of one ſpecies of plant into the piſtil, or utricle of another.

The carnation and ſweet-william being ſomewhat alike in their parts, particularly their flowers; the farina of the one will impregnate the other; and the ſeed ſo enlivened will produce a plant differing from either.

This gives us a hint for altering the property and taſte of any fruit, by impregnating one tree with the farina of another of the ſame claſs, *e gr.* a codlin with a pearmain, which will occaſion the codling ſo impregnated to laſt a longer time than uſual, and be of a ſharper taſte; or if the winter-fruits be fecundated with the duſt of the ſummer-ſeeds, they will decay before their uſual time.

Among the monſtrous productions of the ſea, the *mermaid* is that, which ſurpriſes and puzzles us moſt.

However naturaliſts may doubt of the reality of *mermen* or *mermaids*, we have teſtimony enough to eſtabliſh it.

In the year 1430, after a huge tempeſt, which broke down the dykes in *Holland*, and made way for the ſea into the meadows, ſome girls of the town of *Edam* in *Weſt Frieſland*, going in a boat to milk their cows, perceived a *mermaid* embarraſſed in the mud, with a very little water. They took it into their boat, and brought it with them to *Edam*, dreſſed it in woman's apparel, and taught it to ſpin. It fed like one of them, but could never be brought to offer at ſpeech. Some time afterwards it was brought to *Haerlem*, where it lived for ſome years, though ſtill ſhewing an inclination to the water. *Purival* relates, that they had given it ſome notion of a deity.

From the deſcription of *monſters*, I'll paſs to what appears the moſt capable to flatter our curioſity, in the *animal world*.

The UNICORN is an animal famous among the *Greek* authors under the name of μονοκερως; having *one horn* only, which is repreſented as five palms long, growing in the middle of the forehead.

The popular account is, that it is about the ſize of a horſe, its hair ſhort, and of a dark-brown

colour; very timorous, and therefore keeping moſtly in the woods; and that its true place is the province of *Agoas*, in the kingdom of *Damotes* in *Ethiopia*.

The firſt author who wrote of the *unicorn*, was one *Creſius*, whom *Ariſtotle* mentions as a very ſuſpicious author. And the more knowing among the moderns unanimouſly hold it a fabulous animal.

What ordinarily paſſes among us for *unicorn's horn*, and is ſhewn for ſuch in the collections of curioſities, and uſed for ſuch by ſeveral phyſicians, we are aſſured by *Pereyra*, in his account of *Greenland*, is the tooth of a large fiſh of the whale-kind, called by the iſlanders *narval*; and in others places *walrus* and *rohart*, frequent enough in the icy ſea. This tooth or horn, turned, channelled, and terminated in a point, as it is, ſprings out of the middle of the fore-part of the upper jaw, and ſerves it as a weapon of defence, wherewith it dares to attack the largeſt whale. It can ſtrike it with ſuch violence, as even to pierce the ſide of a ſtrong built ſhip.

Among the feathered tribe, the PHOENIX was a bird famous among the antients; but generally look'd upon by the moderns as fabulous.

The naturaliſts ſpeak of it as ſingle, or the only one of its kind: they deſcribe it as of the ſize of an eagle; its head finely creſted with a beautiful plumage. Its neck covered with feathers of a gold colour, and the reſt of its body purple, only the tail white, intermixed with carnation; and its eyes ſparkling like ſtars. They hold that it lives five or ſix hundred years in the wilderneſs: that when thus advanced in age, it builds itſelf a funeral pile of wood and aromatick gums; then it lights it with the wafting of its wings, and thus burns itſelf; and from its aſhes ariſes a worm, which in time grows up to be a *phœnix*.

Hence the *Phœnicians* gave the name *phœnix* to the palm-tree, by reaſon when burnt down to the very root, it riſes again fairer than ever.

In the ſea we find the TORPEDO, which is a flat fiſh, much of the figure of the thorn-back, found about the coaſts of *Provence*, *Gaſcony*, &c. where the people eat it without any danger.

Upon touching the *torpedo* with the finger, it frequently, though not always happens, that the perſon feels an unuſual painful numbneſs, which ſuddenly ſeizes the arm up to the elbow, and ſometimes to the very ſhoulder and head; reſembling that painful ſenſation felt in the arm, upon ſtriking the elbow violently againſt a hard body.

Bellonius aſſures us, that *torpedo*'s applied to the ſoals of the feet, have prov'd ſucceſsful againſt fevers.

From the *animal* I'll paſs to the *vegetable* world, and there take a particular notice of the *ginſeng*.

The GIN-SENG, or GIN-SEM, or GINZENG, is a very extraordinary and wonderful plant, hitherto found in *Tartary* and *North America*.

The *gin-ſeng* is one of the principal curioſities of the *Chineſe* and *Tartars*; their moſt eminent phyſicians have wrote many a volume of its virtues.

It is known among them by divers other names, as the *only ſpirituous*, the *pure ſpirit of the earth*, the *plant that gives immortality*, &c.

The *gin-ſeng* has a white root ſomewhat knotty, about thrice the thickneſs of the ſtem and which goes tapering to the end: at a few inches from the head it frequently parts into two branches, which gives it ſome reſemblance of a man, whoſe thighs the branches repreſent; and is hence it takes the denomination *gin-ſeng*.

From the root riſes a perfectly ſmooth and tolerable round ſtem; its colour is a pretty deep red, except towards the foot, where, by the neighbourhood of the earth, it is turned ſomewhat whiter. At the top of the ſtem is a ſort of joint or knot, formed by the ſhooting of four branches, which ſpread as from a centre: the underſide of each branch is green mixed with white, and the upper part much like the ſtalk, of a deep red; the two colours gradually decreaſe, and at length unite on the ſides.

Each branch has five leaves; and it is obſervable, that the branches divide equally from each other, both in reſpect of themſelves, and of the horizon; and with the leaves make a circular figure nearly parallel to the ſurface of the ground.

The fibres of the leaves are very diſtinguiſhable, and on the upper ſide are beſet with ſmall whitiſh hairs; the membranes or pellicles between the fibres riſe a little in the middle, above the level of the fibres.

The colour of the leaf is a dark green above, and a ſhining whitiſh green underneath, and all the leaves are finely jagged or indented.

On the edges, from the center of the branches, ariſes a ſecond ſtalk, very ſtrait, ſmooth, and whitiſh, from bottom to top, bearing a bunch of round fruit, of a beautiful red colour. This bunch, in the plant viewed by F. *Jartoux*, a jeſuit, was compoſed of twenty-four berries.

The red ſkin that covers the berries is very thin and ſmooth, and contains within it a white pulp: as theſe berries were double (for they are ſometimes ſingle) each had two rough ſtones, of the ſize and figure

figure of our lentils. The pedicles whereon the berries were ſupported, all aroſe from the ſame center, and ſpreading exactly like the radii of a ſphere, made the bunch of berries of a circular form. The fruit is not good to eat, and the ſtone includes a kernel; it has alſo a ſmall beard at the top, diametrically oppoſite to the pedicle.

The plant dies away every year, the number of its years may be known by the number of ſtalks it has ſhot forth, of which there always remains ſome mark.

Though the plant here deſcribed had four branches, yet there are ſome which have but two, others three, and others five, ſix, or ſeven; but each branch has always five leaves.

The height of the plant is proportionable to its bigneſs; and the number of branches that the root has, the larger and more uniform it is; and the fewer ſmall ſtrings or fibres it has, the better it is accounted.

Thoſe who gather the *gin-ſeng*, preſerve only the root, and all they can get of it in ten or fifteen days time, they bury together in ſome place under ground. Then they take care to waſh it well, and ſcour it with a bruſh; then dip it in ſcalding water, and prepare it in the fumes of yellow millet, which gives it part of its colour.

The millet is put in a veſſel with a little water, and boiled over a gentle fire; the roots are laid over the veſſel upon ſmall tranſverſe pieces of wood, being firſt covered with a linen cloth, or ſome other veſſel, placed over them.

They may alſo be dried in the ſun, or by the fire; but then, though they retain their virtue well enough. they have not that yellow colour, which the *Chineſe* ſo much admire. When the roots are dried, they muſt be kept cloſe in ſome very dry place, otherwiſe they are in danger of corruption, or being eaten by worms.

The *gin ſeng* is an ingredient in moſt of the medicines, which the *Chineſe* phyſicians preſcribe to the better ſort of patients: they affirm, that it is a ſovereign remedy for all weakneſſes occaſioned by exceſſive fatigues, either of body or mind: that it attenuates and carries off pituitous humours; cures weakneſs of the lungs, and the pleuriſy; ſtops vomiting; ſtrengthens the ſtomach; and helps the appetite; diſperſes fumes or vapours; fortifies the breaſt; is a remedy for ſhort and weak breathing; ſtrengthens the vital ſpirits; and is good againſt dizzineſs of the head, and dimneſs of ſight; and that it prolongs life to extreme old age. Thoſe that are in health, often make uſe of it to render themſelves more vgorous and ſtrong.

It ſubtilizes, increaſes the motion of, and warms the blood; it helps digeſtion, and invigorates in a very ſenſible manner.

It is neceſſary to boil it a little more than tea; as is practiſed by the *Chineſe*, when they give it to ſick perſons. On which occaſion they ſeldom uſe more than the fifth part of an ounce of the dried root.

To prepare the root for exhibition, cut it into thin ſlices, and put it into an earthen pot well glazed, with about half a pint of water; the pot to be well covered, and ſet to boil over a gentle fire; and when the water is conſumed to the quantity of a cup-full, a little ſugar to be mixed with it, and to be drank: immediately after this, as much more water to be put on the remainder, and to be boiled as before, to extract all the juice, and what remains of the ſpirituous part of the root. Theſe two doſes to be taken, the one in the morning, and the other in the evening.

A tree grows, likewiſe, in *China*, *Lao*, and *Coehin-china*, called the *aloe-tree*, which is much about the ſize and figure of olive-trees. The trunk conſiſts of three ſorts of wood, very different in colour and properties. Immediately under the bark, it is black, compact and heavy, called by the *Portugueſe*, *pao d'aquilo*, q. d. eagle wood. The next under this is of a tan-colour, light and veiny, reſembling rotten wood; and called *calambo*.

The heart or innermoſt part is called *tamback*; and more valued by the *Indians* than gold itſelf. It affords a very ſtrong, but agreeable ſmell; and is uſed as a perfume; and is withal held a ſovereign remedy againſt the palſy, deliquium, weakneſs, *&c.*

It is the *calambo* alone which is known among us. It is brought in ſmall bits of a very fragrant ſcent; eſpecially when caſt on the fire, where it melts like wax. The beſt is of a blackiſh purple colour, and ſo light as to ſwim on water: it is hot and drying; and eſteemed a great ſtrengthener of the nerves.

In the *Weſt Indies*, particularly in the provinces of *Guanimala*, and *Nicaragua*, and the *Caribbee* iſlands, grows a tree, reſembling our cherry-tree, which produces a kind of nut about the ſize of an almond, called *cacao*, or *cocoa*.

The native *Mexicans* called the *cacao-tree*, *cuchaa*, *guahuets*; it is ſo very delicate, and the ſoil it grows in ſo hot, that to guard it from the ſun, they always plant it in the ſhade of another tree, called *mother of cacao*.

The fruit is encloſed in a kind of pod, of the ſize and figure of a cucumber; except that it begins, and ends in a point. Within the pod, which is half a finger thick, is formed a tiſſue of white fibres, very ſucculent, a little acid, and proper to appeaſe thirſt. In the middle of theſe fibres are contained 10, ſometimes 12, and ſometimes more,

as far as 40 grains or ſeeds, of a violet colour, and dry as acorns. Each grain, which is covered with a little bark or rind, when ſtripped thereof, ſeparates into five or ſix unequal pieces, in the middle whereof is a kernel or pippin, having a tender bud, very difficult to preſerve.

Of this ſeed, with the addition of *vanilla*, and ſome other ingredients, the *Spaniards*, and after their example, the reſt of *Europe*, prepare a kind of conſerve or cake; which diluted in hot water, makes that delicious wholeſome drink, called *chocolate*.

The *Cacao* nuts are eſteemed by the *Mexicans* as anodyne; and uſed, eaten raw, to aſſwage pains of the bowels. They alſo procure a kind of butter or oil from them, as ſweet as that of almonds, and drawn in the ſame manner, excellent for burns.

From this I'll paſs to *foſſils*, &c. and examine firſt the GLOSSOPETRA, which is a kind of ſtone, in form of a ſerpent's tongue, commonly found in the iſland of *Malta*, and divers other parts.

Naturaliſts are divided as to the nature and origin of theſe ſtones.

The vulgar opinion is, that they are the tongues of ſerpents petrified; and hence their name, which is a compound of γλωσσα, tongue, and πίτρα, ſtone. Hence alſo their pretended extraordinary virtue in curing the bites of ſerpents.

The common opinion of Naturaliſts is, that they are the teeth of fiſhes, left at land by the waters of the deluge; and ſince petrified.

SHELLS are alſo one of the chief objects of *natural hiſtory*. The *ſhells* of garden ſnails are formed of a matter, which perſpires from their bodies, and hardens and condenſes in the air.

SHELLS, *conchæ*, or *cochleæ*, make a conſiderable article in the cabinet of the curious: the fineſt and rareſt are theſe that follow, *viz.* the *papal crown*, *tiaraa pontificia*, which takes its name from its form, and which is all ſtreaked with red on a white ground. The *feather*, *pluma*, whoſe whiteneſs, with its carnation ſtains, have an admirable effect. The *hebraica*, which on a ground as white as ſnow, has ſpots as black as jet, much reſembling *Hebrew* characters. The *Chineſe ſnail*, *limax ſinicus*, which has a green and black embroidery, on a dark brown ground. The *cloth of gold*, *textile aureum*, remarkable for an admirable tiſſue of yellow, brown, and black. The *cloth of ſilver*, *textile argenteum*, which does not come behind that of gold in beauty. The *leopard*, *pardus*, which is all ſpeckled. The *tyger*, *tigris*, *ſeu concha cirenicea*, whoſe ſpots exceed thoſe of the leopard. The *hart's horn*, *cornu cervinum*, which has black ſtains on a white ground. The *purſe*, *crumena*, thus called from its figure; it is embroidered with three or four colours. The *ſun-dial*, *ſolarium manuarium*. The *caterpillar*, *cruca*, both denominated from their forms. Add the *nerites*, *nautilus*, *lepas*, *lepaſia*, *apporays*, *tuba*, *galea*, &c.

In *Aldrovandus*, *Geſner*, and *Fabius Columna*, we have all that the antients have ſaid on the ſubject of *ſhells*. In 1692, Dr. *Liſter* publiſhed a *natural hiſtory* of *ſhells* in folio, full of cuts, repreſenting the various kinds of ſhells. Under the firſt claſs he ranges the terreſtrial or land *ſhells*; in the ſecond, the freſh water *ſhells*, both thoſe called *turbinata*, and thoſe *bivalvia* and *multivalvia*: and in the fourth he divides into ſeveral claſſes, the ſea *ſhells*, called *turbinata*. The *turbinated* are thoſe which are ſpiral, or wreathed, conically, from a larger baſis to a kind of *apex*. *Bivalve* is a term uſed for ſuch ſhell-fiſh, as have two ſhells, *e. gr.* cockles, muſcles, oyſters, &c. which are ſaid to be of the *bivalvular* kind.

Shells are frequently found under ground in places far remote from the ſea, in mines, and even on the tops of mountains.

Dr. *Liſter* judges, that the *ſhells* found in ſome quarries were never any part of an animal; and gives this reaſon for it, that quarries of different ſtones, yield quite different ſpecies of *ſhells*; different not only from one another, but from any thing in nature beſides, which either ſea or land does yield.

The ſea *ſhells*, which are always found near the ſhores, and never far off in the deep, are called *litoral ſhells*.

Thoſe which are found in the bottom of the ſea, remote from the ſhore, are called *pelagiæ*.

The SPAR has alſo its place in *natural hiſtory*, and is a ſhining, ſtony, mix'd ſubſtance, compounded of cryſtal, incorporated with *lac lunæ*, or other mineral, earthy, ſtony, or metallick matter; frequently found in caves and grotto's, and in the clefts of rocks, lead-mines, &c.

Mr. *Beaumont* in the *Philoſophical Tranſactions*, endeavours to account for the origin and growth of *ſpar*; which he makes to be a kind of rock-plant.

Spar, he obſerves, may be formed three ways; either from ſtreams alone; or from ſteams coagulating dew, as it falls on the ground, or waters iſſuing from the joints of rocks: or it may grow from earth and clay.

The STALACTITES, or STALAGNITES, or STANONITES, is a ſtarry, ſparry ſort of icicles, which hang down from the tops or arches of grot-

to's,

to's, and ſubterranean caverns; and from the roofs of buildings, and capitals of pillars of ſuch places as are built over hot ſprings, &c.

Of this kind are the *ſal alumen*, and *vitriolum ſtalactticum*; the *minera ferri ſtalactica*, the *vitriolum capillare*, &c.

The *ſtalactites*, which incruſtate or line the tops and ſides of caves, &c. are manifeſtly formed of exſudations or extillations of petrifying juices out of the neighbouring rocky grounds.

There is, alſo, in natural hiſtory, a kind of figured foſſil ſtones, reſembling plants, called TROCHITÆ, or TROCHITES, vulgarly *St. Cuthbert's beads.*

They are uſually of an opake, dark colour, break like flint, gloſſy and ſhining, and are eaſily diſſolved in vinegar.—Their figure is generally cylindrical, ſometimes a little tapering; the circumference ſmooth, and both the flat ſides covered with a fine radii, drawn from a certain hole in the middle to the circumference.—Two or three, or more of theſe *trochitæ* joined together, conſtitute what the naturaliſts call an *entrochos.*

The *trochitæ*, or ſimple joints, are ſo ſet together, that the rays of one enter into furrowsi n the other, as in the ſutures of the ſkull.—They are found in great plenty in the bodies of the rocks at *Broughton* and *Stock*, two villages at *Craven*, at all depths under ground; and in *Mendip* hills, &c. ſometimes only ſprinkled here and there, and ſometimes in large ſtrata, or beds of all magnitudes, from the ſize of the ſmalleſt pin, to two inches about.

They are generally found ramous and branchy, larger branches ariſing from the ſtem, or cylinder, and ſmaller from them: the branches being deeply inſerted into the ſtem, the tearing them off leaves great holes therein.

In the clay where trochites are found, the ſtone called *cornu ammonis* is frequent.

The CORNU AMMONIS is an extraordinary kind of ſtone, which in vinegar, juice of lemons, &c has a motion like that of an animal.

It is rough, knotty, of an aſh-colour, and crooked in manner of a ram's horn, ſuch as thoſe, wherewith the antients repreſented *Jupiter Ammon*; whence its name.

The *cornua ammonis* are of different thickneſſes and lengths; ſome of them weigh about three pounds: they are found in ſeveral places in *Germany*. From ſome experiments that have been made therewith, they are found to contain a little quantity of gold, which ſinks to the bottom upon pounding them ſmall, and ſtirring them in a running water, till all the earthy parts are carried off

I'll conclude this treatiſe by a diſſertation on *ſeeds*, and on the bodies fecundated thereby, viz. *eggs.*

SEED, taken in the general ſignification of the word, is a matter prepared by nature, for the reproduction and conſervation of the ſpecies, both in men, animals, and plants.

Some Naturaliſts add, that even ſtones, minerals, and metals themſelves, have each their proper ſeed in their mines, and are produced and perpetuated thereby.

Seed, in the animal œconomy, is a white liquid matter, or humour, the thickeſt of any in the body, ſeparated from the blood in the teſticles, and reſerved in proper veſſels to be the means of generation.

The *ſeed*, or humour formed in the teſticles, being, when new, diluted with a little warm water, and viewed with a good microſcope, ſeems to conſiſt of innumerable, little, oblong, living, eels-like *animalcula*, floating in the other part of this humour. This is ſaid to be always obſerved in the *ſeed* of all men, quadrupedes, birds, fiſhes, amphibious animals, and inſects.

Seed, in *Botany*, is the laſt product of a plant, whereby the ſpecies is propagated. The *ſeed* is frequently the fruit of the plant, as is the caſe of moſt herbs. Sometimes it is only a part incloſed in the fruit, and that in form either of grain, kernel, or berry.

The *ſeed* is the natural offspring of the flower, and that for whoſe production all the parts of the flower are intended; ſo that when this is once well formed, the ſeveral parts of the flower dwindle and diſappear.

It is ſuppoſed to be produced by the farina of the apices, let fall on the head of the piſtil, and thence forwarded to an uterus at the bottom thereof, divided into ſeveral cells; where, coming to receive the nutritious juice of the plant, it is firſt ſoftened, then ſwelled, increaſed both in matter and bulk, and at length comes to its ſtate of maturity.

That the whole plant is contained in the ſeed, is an opinion as old as *Empedocles*, and is ſtill the prevailing doctrine among the generality of Naturaliſts. Experience, the microſcope, and the modern philoſophy, give it great countenance. In effect, by the uſe of good microſcopes, we diſcover in the *ſeed* ſeveral of the parts of the future tree, only in miniature; particularly a little root called the *radicle*, and the ſtem called the *plumule.*

The fecundity of plants in the production of *ſeed*, is very ſurprizing. M. *Dodart*, in the Memoirs of the *French* academy of ſciences, computes, that an elm, living 100 years, ordinarily produces of itſelf 33000000 grains.

The

The Mushroom is a plant of a form and ſtructure very different from that of all other plants. It has neither ſeeds, nor flowers.

M. *Tournefort* gives a very curious account of their culture, in the Memoirs of the Royal Academy, with the ſubſtance of which we ſhall here preſent the reader. All the ſecret of bringing up *muſhrooms* ſpeedily, and in abundance, conſiſts in ranging balls of horſe-dung, about the bigneſs of the fiſt, in lines, at the diſtance of about three feet from each other, and at the depth of one foot under ground, and covering theſe over with mould, and that again with horſe-dung.

If this be done in *April*, in the beginning of *Auguſt* the pieces of dung will begin to whiten, and grow mouldy, being cover'd all over with little hairs, or fine white threads, branched and woven about the ſtraws whereof the dung is compoſed. The dung now looſes its former excrementitious ſmell, and ſpreads an admirable odour of *muſhrooms*.

According to all appearance, theſe white threads are no other than the open'd *ſeeds* or buds of *muſhrooms*, which *ſeeds* were before incloſed in the dung, but in ſo ſmall a compaſs, that they could not be perceived till after they had ſhot themſelves into little hairs. By degrees the extremity of theſe hairs grows round, into a kind of button, which ſwelling by little and little, at length opens itſelf into a *muſhroom*, whereof the lower part is a kind of pedicle bearded in the place where it enters the ground, and at the other end loaded with a roundiſh capital or head, in the manner of a ſhalot, which expands itſelf, without producing either *ſeeds* or flowers that are ſenſible; the bottom is ſpread with laminæ, which proceeding from the center to the circumference, may be called the leaves of the *muſhrooms*.

At the foot of each *muſhroom*, are found an infinite number of little ones, not bigger than the head of a pin, when the others are at their growth. The buds of the *muſhrooms*, or the white hairs of the dung, preſerve themſelves a long time without rotting, if kept dry; and if laid again on the ground will produce new *muſhrooms*.

Muſhrooms, then, are nothing elſe but the produce of what we call the *mouldineſs* of *horſe-dung*: but what analogy is there between theſe two things? or how ſhould ſo artful and delicate a ſtructure as this of a plant, reſult frrm the mere fortuitous concourſe of a few juices differently agitated?

It ſeems paſt doubt, then, that *muſhrooms*, like all other plants, have their origin in *ſeeds*.

There are various kinds of *muſhrooms*; and the vulgar call by this name all that come under the general name of fungus's; by the *Greeks* called μυκητες.

Mr. *Bradley* mentions a hundred kinds of *muſhrooms*, which he has ſeen in *England*; beſides thoſe very numerous ſmall ones, which conſtitute the mouldineſs of liquors, fruits, *&c.* which laſt are ſuch quick growers, that they arrive at perfection in leſs than twelve hours.

The *fungoides* only differs from a *muſhroom* in its external form; the *coralloides* are of the ſame ſpecies, though of a different name, as being branched like coral, and truffles come under the ſame kind.

Mathiolus mentions *muſhrooms*, which weighed thirty pounds each, and were as yellow as gold. *Fer. Imperatus* tells us, he ſaw ſome which weighed above a hundred pounds; and to add no more, the *Journal des Scavans* furniſhes us with an account of ſome growing on the frontiers of *Hungary*, which made a full cart-load.

Truffles, *tubera terræ*, is a kind of ſubterraneous vegetable production, not unlike *muſhrooms*.

The antient Phyſicians and Naturaliſts, rank *truffles* in the number of roots, bulls, or cloves; and define them to be a ſpecies of vegetables, without ſtalks, leaves. fibres, *&c.* *Bradley* calls them *under ground edible muſhrooms*, or *Spaniſh trubbes*.

They are produced moſt in dry chapped grounds, and that, as *Pliny*, ſays, chiefly after rains and thunder, in *autumn*. Their duration he limits to a year. Their colour is uncertain; ſome being white, others black, *&c.*

In *Italy*, *France*, &c. they eat them as a great dainty, either fryed in ſlices with oil, ſalt, or pepper, or boiled over again in their own broth. The hogs are exceedingly fond of them, and are frequently the means of diſcovering the places where they are; whence the common people call them *ſwine-bread*. The modern Botaniſts rank *truffles* in the number of plants, though they want moſt of the uſual parts thereof. All we know of their growth is, that they are firſt no bigger than a pea, reddiſh without, and within whitiſh, and that as they ripen, the white parts grow more duſky and black; only there are ſtill left a number of white ſtreaks, which all terminate at places where the outer coat is cracked, or open: and which, in all probability, are the veſſels that convey the nouriſhment into the *truffles*.

In theſe veſſels is found a whitiſh matter, which, when viewed with a microſcope, appears to be a tranſparent parenchyma, conſiſting of veſiculæ: in the middle whereof are perceived little round black grains, ſeparate from each other, ſuppoſed to be the *ſeed* of the *truffles*.

They

They are tendereſt and beſt in the ſpring, tho' eaſieſt found in autumn; the wet ſwelling them, and the thunder and lightning diſpoſing them to ſend forth their ſcent, ſo alluring to the ſwine. Hence ſome of the antients call them *ceraunia*, q. d. *thunder-ſtones*.

The antients are exceedingly divided as to the uſe of *truffles*; ſome affirming them to be wholeſome food; and others pernicious. I am of opinion, they have both good and evil effects; they reſtore and ſtrengthen the ſtomach, promote the ſemen, *&c.* But when uſed too freely, they attenuate and divide the juices immoderately, and by ſome volatile and exalted principles, occaſion great fermentations, *&c.* though the pepper and ſalt they are ordinarily eaten withal, do doubtleſs contribute greatly to thoſe effects.

We muſt inform ourſelves next what *eggs* are.

EGG is a part formed in the female of certain animals; which, under a ſhell or cortex, includes an embrio or fœtus, of the ſame ſpecies; the parts whereof are afterwards diſplayed and dilated, either by incubation, or by the acceſſion of a nutritious juice.

The ſpecies of animals that produce *eggs*, are particularly denominated *oviparous*; and the part wherein the *egg* is formed the *ovary*.

An *egg*, improperly ſo called, is that of the whole whereof the animal is formed: ſuch are the *eggs* of flies, butterflies, *&c.* which *Ariſtotle* calls *vermiculi*.

The two have this further difference, that whereof the former, after they are excluded from the female, need no external nutriment, nor any thing but warmth and incubation, to bring the fœtus to perfection: the latter, after they are fallen out of the *ovary* into the *uterus*, require the nutritious juices of the *uterus* to diſtend and enlarge them; whence they remain much longer in the *uterus* than the other.

It was antiently thought, that none but birds and fiſhes, with ſome other animals, were produced *ab ovo*, *eggs*; but the generality of the moderns incline to think, that all animals, even man himſelf, is generated the ſame way. *Harvey*, *De Graaf*, *Kerckringius*, and ſeveral other great *Anatomiſts*, have ſo ſtrenuouſly aſſerted this opinion, that it now generally obtains.

In the teſtes of women, are found little veſicles, about the ſize of green peas, which are accounted as *eggs*; for which reaſon, theſe parts, which the antients called *teſticles*, the moderns call *ovaries*. Theſe *eggs* fecundified by the moſt volatile and ſpirituous parts of the ſeed of the male, are detached from the *ovary*, and fall down the fallopian tubes into the *uterus*, where they grow and increaſe.

This ſyſtem is countenanced and confirmed by abundance of obſervations and experiments. M. *de St. Maurice*, upon opening a woman at *Paris*, in 1682, found a fœtus perfectly formed in the teſticle.

There is not ſo much as a plant, whoſe generation, according to the ſentiment of *Empedocles*, and ſince him of *Malpighi*, *Rallius*, *Fabric. de Aquapendente*, *Grew*, and others, is not effected by the way of *eggs*.

On the other hand we have many inſtances of *viviparous* animals producing their young abſolutely alive, and without *eggs*. Such inſtances we have of a crow, a hen, ſerpents, fiſhes, eels, *&c.*

ANIMALCULE, is a diminutive of animal, and expreſſes ſuch a minute creature, as is ſcarce, or not at all diſcernable by the naked eye.

Such are thoſe numerous inſects which crowd the waters in the ſummer-months, changing it ſometimes of a deep or pale red colour, ſometimes a yellow, *&c.* they ſeem to be of the ſhrimp kind, called by *Swammerdam*, *pulex aquaticus arboreſcens*. The cauſe of their concourſe at this time, Mr. *Derham* obſerves, is to perform their coit. He adds, that they afford a comfortable food to many water-animals. The green ſcum on the top of ſtagnant waters is nothing elſe but prodigious numbers of another ſmaller order of *animalcules*; which in all probability ſerve for food to the *pulices aquatici*.

The microſcope diſcovers legions of *animalcules* in moſt liquors, as water, wine, brandy, vinegar, beer, ſpittle, urine, dew, *&c.* In the *Philoſophical tranſactions*, we have obſervations of the *animalcules* in rain-water, in ſeveral chalybeat waters, infuſions of pepper, ivy-berries, oats, barley, wheat, *&c.*

The human ſeed has been obſerved by divers authors to contain huge numbers of *animalcules*, which gave occaſion to the ſyſtem of generation *ab animalculo*.

Leaves may alſo claim a place in this treatiſe; therefore,

LEAF, is a part of a plant, ordinarily very thin and flat, growing in the ſpring, and falling off in autumn.

As to the ſtructure of *leaves*, Dr. *Green* obſerves, that their fibres never ſtand on the ſtalk on an even line, but always in an angular or circular poſture, and their vaſcular fibres or threads are 3, 5, or 7. The reaſon of which poſition is for their more erect growth, and the greater ſtrength of the *leaf*.

The ſkin or coat of the leaves, is no more than that of the branches extended, as gold, by beating, is reduced into *leaves*. In the gem the leaves

are

are folded, ſometimes in two, and ſometimes in ſeveral plaits, ſomewhat after the manner of a fan. If the leaves be too thick to plait commodiouſly in two, and to be ranged againſt each other; or if they be in too ſmall a number, and their fibres too delicate, inſtead of being plaited they are rolled up, and form either a ſingle roll, as the *leaves* of the mountain-cowſlip, which are thick; or two rolls, which begin at each extremity of the *leaf*, and meet in the middle. There are alſo ſome plants whoſe *leaves* form three rolls, as fern; ſeveral *leaves* are covered with hair of ſeveral figures; thoſe of lavender and olive-tree, have hairs reſembling ſtars.

Botaniſts conſider the *leaves* of plants, with regard to their ſtructure, ſurface, figure, conſiſtence, edges, ſituation and ſize.—With regard to their ſtructure, *leaves* are either *ſingle*, as thoſe of the apple-tree, pear-tree, *&c.* or *double*, as thoſe of angelica, parſley, *&c.*—With regard to their ſurface, *leaves* are either *flat*, as the nummularia, aſarum, origany, androſænum, brionia canadenſis, *&c.* or *hollow*, as thoſe of the onion and aſphodel; or in *bunches*, as ſeveral kinds of kali, and houſe-leeks.—With regard to their conſiſtence, *leaves* are either thin and fine, as thoſe of St. John's-wort, and dog's graſs; or thick and groſs, as thoſe of portulaca; or fleſhy, as thoſe of ſeveral kinds of houſe-leeks; or woolly, as thoſe of the wool-blade.—With regard to the verge or edges, *leaves* are either cut ſlightly, as ſome ſpecies of gum, and cannabis lutea; or deep, as trefoil, *&c.*—With regard to their ſituation, *leaves* are either alternate, that is, ranged alternately, as the philyca; or oppoſite to each other, as the philerya, and ſome ſpecies of the rubia.—With regard to their ſize, *leaves* are either very big, as thoſe of the colonſia, and ſphondylium; moderate, as thoſe of the biſtorte, the fig-tree; ſmall, as thoſe of the apple-tree, pear-tree; peach-tree, or very ſmall, as thoſe of millepertuis, or St. John's-wort.

There are likewiſe, annual, crenated, diſſimilar, procumbent, ſegment, ſeminal, and vernal *leaves*.

Annual leaves, are ſuch *leaves* as come up afreſh in the ſpring, and periſh in the winter.

Crenated leaves, are ſuch *leaves* as are jagged or notched.

Diſſimilar leaves, denote the two firſt *leaves* of any plant, at its firſt ſhooting out of the ground. They are thus called, becauſe they uſually are of a different form from the common *leaves* of the grown plant.

Procumbent leaves, are ſuch leaves as lie flat, and trailing on the ground.

Segment leaves, is a Denomination given to thoſe *leaves* that are cut and divided into many ſhreds, or ſlices, as fennel, *&c.*

Vernal leaves, are thoſe *leaves* which come up in the ſpring.

NAVAL ARCHITECTURE.

NAVAL ARCHITECTURE, or *ſhip-building*, is that which teaches the conſtruction of ſhips, galleys, and other floating veſſels for the water; with ports, moles, docks, *&c.* on the ſhore.

A *ſhip*, is defined by the Sieur *Aubin*, a timber-building, conſiſting of various parts, or pieces, nailed and pinned together with iron and wood, in ſuch form as to be fit to float, and to be conducted by wind and ſails from ſea to ſea.

Ships, are uſually divided into three claſſes; *ſhips of war*, *merchant-ſhips*, and an intermediate kind, half war, half merchant; being ſuch, as though built for merchandize, yet take commiſſions for war.

Ships of war, are again divided into ſeveral orders, called *rates*; which are ordinarily ſix, *viz. firſt*, *ſecond*, *third*, *fourth*, *fifth*, and *ſixth rate*; the *rate* being uſually accounted by the length and breadth of the gun-deck; the number of tons, and the number of men and guns the veſſel carries.

A *firſt* RATE *Engliſh* man of war, has its gun-deck from 159 to 174 feet in length; and from 40 to 50 feet broad, containing from 1313 to 1882 tons; has from 800 to 1000 men; and carries from 96 to 110 guns.—A *French* man of war of that rate, has from 1000 to 1200 men.

Second RATE ſhips have their great deck from 153 to 165 foot long; and from 41 to 46 broad; they contain from 1086 to 1482 tops; and carry from 524 to 640 men; and from 84 to 90 guns.—A *French* ſhip of the ſame rate, carries from 900 to 1000 men.

Third RATES, have their gun-deck from 142 to 158 feet in length; from 37 to 42 feet broad; they contain from 871 to 1262 tons; carry from 389 to 476 men; and from 64 to 80 guns.

Fourth RATES are in length, in the gun-deck, from 118 to 146 feet; and from 29 to 38 broad; they contain from 448 to 915 tons; carry from 226 to 346 men; and from 48 to 60 guns.

Fifth RATES, have their gun-deck from 100 to

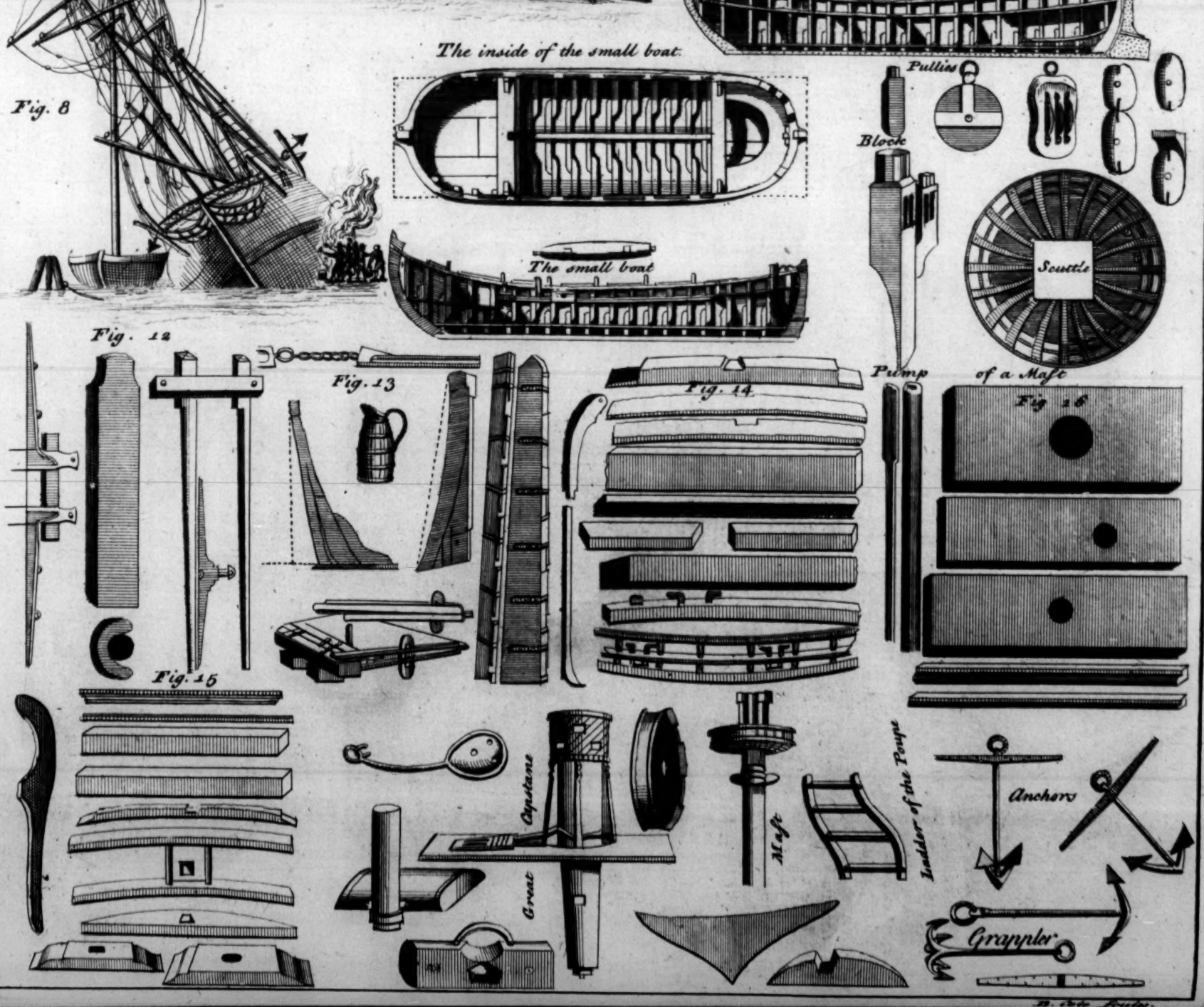


Fig. 8
The inside of the small boat
The small boat
Pullies
Block
Scuttle
Pump
of a Mast
Fig. 12
Fig. 13
Fig. 14
Fig. 15
Fig. 16
Capstans
Great
Mast
Ladder of the Poupe
Anchors
Grappler

NAVAL ARCHITECTURE

Fig. 1

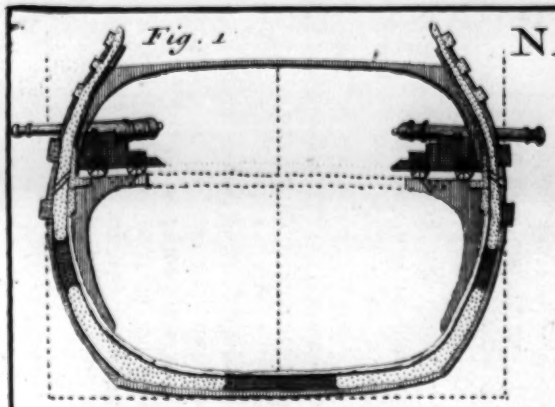


Fig. 2

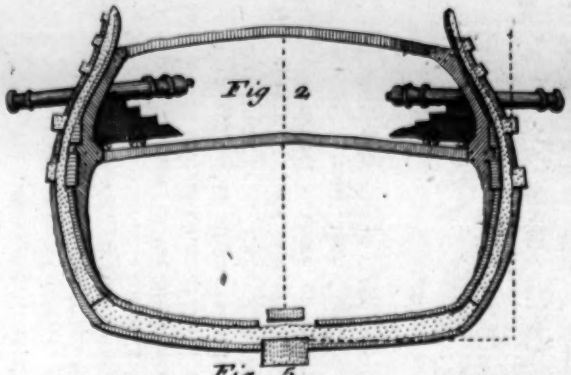


Fig. 3

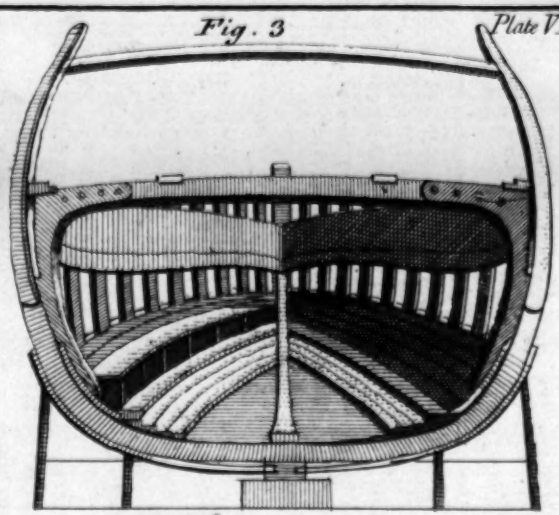


Fig. 4

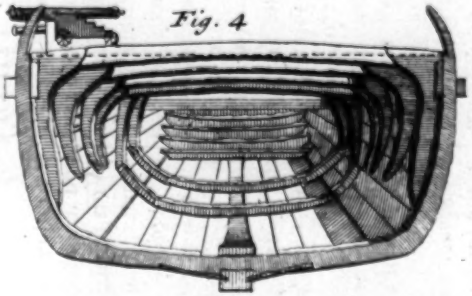
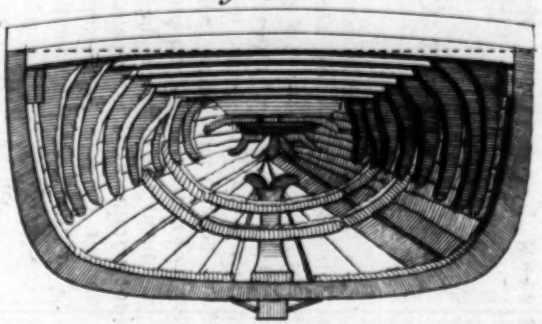
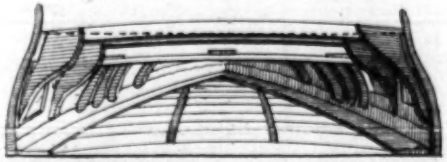


Fig. 5





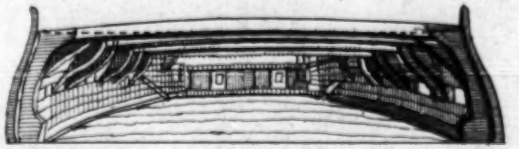


Fig. 6

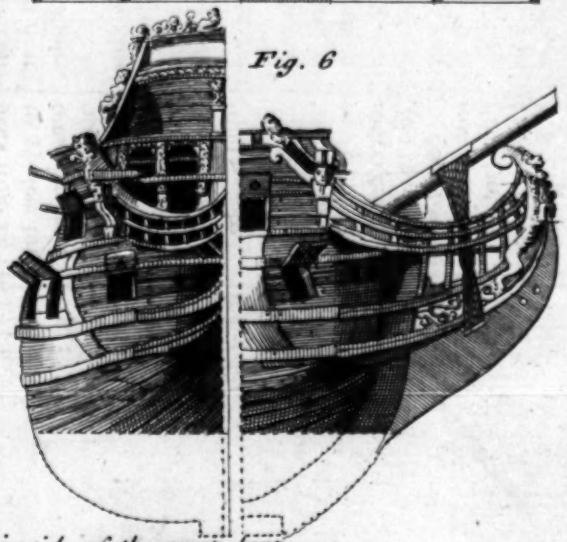
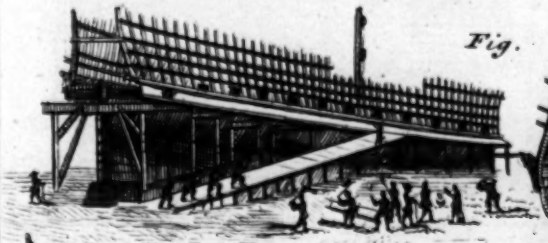


Fig. 7



The inside of the great boat

The great boat

The inside of the small boat.

to 120 feet long; and from 24 to 31 broad; they contain from 259 to 542 tons; carry from 145 to 190 men; and from 26 to 44 guns.

Sixth RATES, have their gun-deck from 87 to 95 feet long; and from 22 to 25 feet broad; they contain from 152 to 256 tons; carry from 50 to 110 men; and from 16 to 24 guns.

Merchant-ships are eſteemed by their burden, that is, by the number of tons they bear; each ton reckon'd at 2000 pounds weight. The eſtimate is made by guaging the hold, which is the proper place of loading.

The different parts of a *man of war* (and in fact almoſt all other ſhips with three maſts) are as follows.

The *keel*, the *ſtern-poſt*, the *rudder*, the *buttock of the ſhip*, the *gallery*, the *freeze*, the *enſign ſtaff*, and its *block*, the *dunette*, or higheſt part of the ſtem of the ſhip, the *half-deck*, or *corps de guard*, which is commonly that part under the *hind-caſtle*, the *fore caſtle* or *prow*, the *belt hooks*, the *cut-water*, the *cannon*, the *port holes*, the *laver*, and *upper check*, the *trail board*, the *figure*, the *grating*, the *brackets*, the *main ſtem*, the *falſe ſtem*, the *bawſe hole*, out of which runs the cable, the *cable*, the *buoy*, and its *orin*; the *mizzen maſt*, the *main-maſt*, the *fore-maſt*, the *bowſprit*, the *mizzen top*, the *main top-maſt*.

A MAST is a large upright pole, or long piece of round wood, raiſed in veſſels, for the rigging to be faſtened to.

In large veſſels the number of *maſts* are three; or four, if we reckon the *bowſprit*, viz. the *main-maſt*, the *fore-maſt*, the *mizen-maſt*, and the *bowſprit*. To which ſome add a fifth, *viz.* a *counter-mizen*, which is very ſeldom uſed.

The *fore-maſt* is between the *main-maſt* and the head.

The *mizen-maſt* is between the *main-maſt* and ſtern.

The *bowſprit* lies upon the beak, in the prow or head of the ſhip.

The *counter-mizen*, in large veſſels and galleons is in the ſtern.

We alſo uſe the word *maſt* to ſignify thoſe diviſions, or additional pieces in the maſts placed over one another.

The *main-maſt*, and *fore-maſt*, have each of them two, *viz.* the *main-maſt*, has the *main top-maſt*, and the *main-top-gallant-maſt*. The *fore-maſt*, has the *fore-top-maſt*, and the *fore-top-gallant-maſt*.

The *mizen-maſt*, has but one, *viz.* the *mizen-top-maſt*.

The *rigging* of the *main-maſt*, are the *runners* and *tackles*; the *tackle*, the *ſhrouds* and *laniards*, the *ſtay* and *ſail*, the *ſtay ſail halliards*, the *yard* and *ſail*, the *jeers*, the *ſheets*, the *tacks*, the *bunt-lines*, the *bowlines*, the *braces*, the *leach-lines*, the *puttock ſhrowds*, the *crowfoot*, the *lifts*, the *top*, the *top armour*, the *top rope*, the *cap*, the *main-yard tackles*.

The *rigging* of the *main-top maſt*, are the *tackles*, *ſhrouds*, *back-ſtays*, *halliards*, *ſtay* and *ſail*, *ſtay ſail halliards*, *yard* and *ſail*, *braces*, *bowlines*, *ſheets*, *clewlines*, *lifts*, *runners*, *buntlines*, *croſs-trees*, *cap*, *ſtump*, *ſtay*, *truck*, *pendant*.

The *rigging* of the *fore maſt*, are the *runner* and *tackles*, the *tackle*, *ſhrouds* and *laniards*, *ſtay*, *yard* and *ſail*, *ſheets*, *tacks*, *braces*, *bowline*, *buntlines*, *leach-lines*, *yard tackle*, *jeers*, *puttock ſhrouds*, *crow-foot*, *top*, *top armour*, *top rope*, *lifts*, *cap*.

The *rigging* of the *fore-top maſt*, are the *tackles*, the *ſhrouds*, the *back ſtays*, *halliards*, *ſtay* and *ſail halliards*, *yard* and *ſail*, *runner*, *lifts*, *braces*, *bowlines*, *ſheets*, *clewlines*, *buntlines*, *croſs-trees*, *cap*, *ſtum*, *ſtay*, *truck*, *ſpindle*, *vane*.

The *rigging* of the *mizen maſt*, are the *yard* and *ſail*, the *ſheet*, *ſhrouds* and *laniards*, *bowlines*, *brayles*, *jeer*, *peak halliards*, *croſs jack yard*, *lifts*, *braces*, *puttock ſhrouds*, *mizen-top*, *top armour*, *cap*, *crow-foot*, *ſtay* and *ſail halliards*.

The *rigging* of the *top maſt*, are the *yard* and *ſail*, *braces*, *lifts*, *ſhrouds*, *halliards*, *back ſtays*, *bowlines*, *ſheets*, *clewlines*, *ſtay*, *croſs-trees*, *cap*, *ſtump*, *ſtay*, *truck*, *ſpindle*, *vane*, *ſlings of the croſs jack yards*.

The *rigging* of the *bowſprit*, are the *horſe*, *yard* and *ſail*, *lifts*, *ſheets*, *clewlines*, *braces*, *bobſtay*, *top*, *top armour*.

The *ſprit-ſail*, *top-ſail*, and the *rigging* of the *top-maſt*, are the *ſhrowds*, *halliards*, *crane line*, *yard* and *ſail*, *braces*, *lifts*, *ſheets*, *croſs-trees*, *cap*, *jack-ſtaff*, *truck*, *jack*, *beſt bower buoy*, and the *cable*.

Weight of Cables *of a hundred fathoms.*

Inches			*Inches*		
A cable of 4 weighs		325	A cable of 11 weighs		2150
4½	—	400	11½	—	2325
5	—	490	12	—	2580
5½	—	558	12½	—	2750
6	—	680	13	—	3000
6½	—	800	13½	—	3250
7	—	930	14	—	3500
7½	—	1060	14½	—	3800
8	—	1200	15	—	3900
8½	—	1340	16	—	5332
9	—	1490	17	—	5900
9½	—	1640	18	—	6600
10	—	1800	19	—	7000
10½	—	1970	20	—	8000
			21	—	9000

A liſt of the *length* and *breadth* of ſome ſhips. and of the *length* and *thickneſs* of the maſts, and of their *tacklings*.

Ships of 142 *feet in length, and* 37 *broad.*

	Feet.		Inch.
The length of the main-maſt	88	*Diam.*	20
of the fore-maſt	78		19
of the bowſprit	52		20
of the mizen-maſt	69		14
of the main-top-maſt	56		13½
of the fore-top-maſt	46		10½
of the mizen-yard	74		10
he length of mizen top gallant,	28		6
of the main-top gallant,	25		6
of the fore-top gallant,	21		5
of the top gallant of the bowſprit,	18		6
Yards.			
The main-yard, feet long,	28		15
— of the fore-maſt,	24		13
— of the bowſprit,	17		8½
— of the main-top maſt,	15		8½
— of the fore-top maſt,	13		8
— of the top-gallant of the bowſprit,	10		4½
— of the main-top gallant,	9		4
— of the fore-top gallant,	7½		3½
Riggings or cordages of the main-maſt.		*Inches*	*Fath.*
Stay,	15		18
Shrowds,	7½		18
Lanniards,	7½		10
Halyard,	8		29
Tacks,	7½		22
Sheets,	4½		39
Lifts,	9		29
Runners and tackles,	9		37
Leach lines,	26	*Threads*	50
Bowlines,	16		14
Braces,	8		35
Buntlines,	8		28
Foremaſt.		*Inches*	
Stay,	12		13
Shrowds,	7		
Lanniards,	7		9
Tacks,	7		20
Sheets,	4		37
Runners and tackles,	9		37
Lifts,	8		27
Halyard,	7½		27
Leach-lines,	24	*Threads*	40
Bowlines,	14		20
Braces,	7		25
Buntlines,	7		27
Mizen-maſt.			
Stay,	6	*Inches*	12
Shrowds,	4		12
Brayles of the top-gallant,	11		36
Sheet,	10		25
Runner of armour,	21	*Threads*	9
Lifts,	21		12
Bowſprit.		*Inches*	
Halyard,	4½		7
Clew line of the top gallant	6		14
Sheets,	7		18
Braces,	5		19
Halyards,	6		22
Buntlines,	5		11
Main-top-maſt.			
Shrowds,	4½	*Inches*	
Tackles,	4½		
Halyard,	5½		9
Stay,	26		22
Sheets,	6		32
Clew-line,	9		57
Bowlines,	10	*Threads*	23
Buntlines,	7		40
Fore-top-maſt.		*Inches*	
Shrowds,	4		
Tackles,	4		
Halyard,	5		7
Stay,	16		14
Lifts,	5		28
Sheets,	33		24
Clew-line,	7		38
Buntlines,	6		37
Braces,	21	*Threads*	27
Bowlines,	21		30

Another manner of rigging a ſhip of 123 feet in length, and 28 in breadth.

Rigging of the top-gallant of the bowſprit.	*Fath.*
The halyard muſt have in length.	3
The lifts,	8
The braces,	18
The clew-line,	16
The buntlines,	18
The ſheet,	18

The tackles of the ſprit-ſail.	*Fath.*
The buntlines,	18
The braces,	18
The lifts of the middle of the yard,	3

Tackles of the main-top gallant.	*Fath.*
The ſtay,	20
The lifts,	10
The halyard,	4
The clew-line,	30
The braces,	32
The buntlines,	23
The bowlines,	30

Tackles of the main-top maſt.	*Fath.*
The ſtay,	21
The lifts,	29
The braces,	30

The

The ſheet,	16
The halyard,	6
The ſafeguard of the bowſprit,	36
The crane-line,	18

Tackles of the fore-top gallant.

	Fath.
The ſtay,	18
The braces,	30
The lifts,	10
The buntlines,	22
The bowlines,	24
The clew-line,	28
The halyard,	3
The ſheets,	24

The tackles of the fore-top maſt.

	Fath.
The ſtay,	15
The runner & tackles,	8
The lifts,	28
The halyard,	7
The braces,	30
The bowlines,	30
The buntlines,	32
The clew-line,	30

Tackles of the fore-maſt.

	Fath.
The ſtay,	12
The runner & tackles	12
The lifts,	28
The braces,	20
The buntlines,	24
The tacks,	14
The bowlines,	15
The ſheets,	36
The halyard,	14
The clew-line,	35
The lanniard,	5
The buntlines,	33
The bowlines,	34
The halyard,	8
The clew-line,	34
The ſtay runner,	18

The tackling of the main-maſt.

	Fath.
The ſtay,	16
The ſtay runner,	16
The lifts,	29
The braces,	30
The ſheets,	30
The tacks,	16
The great bowline,	24
The halyard,	24
The clew-line,	38
The buntline,	26
The lanniard,	6

The tackling of the mizzen top gallant.

	Fath.
The running ſtay,	10
The halyard.	4
The lifts,	10
The ſheets	12
The buntlines	15
The bowlines,	16
The braces,	11

The tackling of the mizzen maſt.

	Fath.
The ſtay,	10
The halyard,	8
The clew-line,	28
The ſheet,	16
The buntlines,	20
The bowlines	18
The lifts,	5

Another manner of cutting the tackling, and of regulating their proportions.

TABLE *of the thickneſs of the threads, and of the weight of cables.*

Thickneſs Inches	*Threads.*	*Weight.* Pounds.	*Thickneſs* Inches.	*Threads.*	*Weight.* Pounds.
3	48	192	13	821	3 284
4	77	308	14	952	3808
5	121	484	15	1093	4372
6	174	696	16	1244	4976
7	238	952	17	1404	5616
8	311	1244	18	1574	6296
9	393	1572	19	1754	7016
10	485	1940	20	1943	7772
11	598	2392	21	2144	8576
12	699	2796	22	2352	9408

In the firſt column of this table is ſeen the thickneſs of the *cables*; in the ſecond column the number of threads; and in the third, the weight of the *cables*.

The meaſure of the *anchors*, and of the *cables* by the bigneſs of the ſhips, to which they muſt ſerve.

Bigneſs of the Ships by Feet.	*Length of the Anchor by Feet*	*Weight of the Anchor by Pds*	*Thickneſs of the Cables by Inches*
8	3 1/3	33	4
9	3 2/3	47	4 1/2
10	4	64	5
11	4 1/3	84	5
12	4 2/3	110	6 1/2
13	5 1/3	140	6 1/2
14	6	175	7
15	6 1/3	216	7 1/2
16	6 2/3	262	8
17	7 1/3	314	8 1/2
18	7 2/3	373	9
19	8	439	9 1/2
20	8 1/3	512	10
21	8 2/3	592	10 1/2
22	9 1/3	681	11
23	9 2/3	779	11 1/2
24	10	884	12
25	10 1/3	1000	12 1/2
26	10 2/3	1124	13
27	11 1/3	1259	13 1/2
28	11 2/3	1405	14
29	12	1562	14 1/2
30	12	1662	15
31	12 1/3	1728	15 1/2
32	12 2/3	1996	16
33	13 1/3	2297	16 1/2
34	13 2/3	2300	17
35	14	2515	17 1/2
36	14 1/3	2742	18
37	14 2/3	2986	18 1/2
38	15 1/3	3242	19
39	15 2/3	3512	19 1/2
40	15 1/3	3796	20
41	15 2/3	4096	20 1/2
42	16	4426	21
43	16 1/3	4742	21 1/2
44	17 1/3	5088	22
45	18	5451	22

A SAIL, is an aſſemblage of ſeveral breadths of canvaſs, or ſtrong hempen cloth, ſewed together by the lifts, and edged round with a cord, faſtened to the yards and cords of a veſſel, to make it drive before the wind.

For the *meaſures* and *proportions* of the *anchors* and *cables*, we muſt take with a compaſs twice the thickneſs of the yard of the *anchor* to find its breadth; then we'll double the inches which the thickneſs gives, and give to the length as many

feet, as there are inches in that thickneſs doubled, and an inch beſides above every foot. For inſtance, the meaſure of the thickneſs being 6 inches by the compaſs, that makes 12 feet for the yard, and by adding 13 inches to it, the whole together make 13 feet 1 inch. Under 1000 pounds, one muſt, *i. e.* for the length of the yard, add 2 inches for each foot, inſtead of 1, which has been marked above; and under 5000 pounds take three times the thickneſs to give the length. Thus when there are two inches and a half of thickneſs, the length muſt be $7\frac{1}{2}$ feet, half whereof, which is $3\frac{3}{4}$, 1 being taken for 100 pounds, the weight of the *anchor* will be 3.

For the thickneſs of the cables in proportion to the weight of the anchors. We muſt obſerve in the two following tables, each whereof conſiſts of 12 articles, that each article of the firſt muſt anſwer to the ſame article in the ſecond. For inſtance, in taking in the firſt article of the firſt table, a cable of 20 inches, you'll find in the ſecond table, at the firſt article, the ſecond line, a common *anchor* of 56 hundred and one fourth weight; which is the proportion of the *anchor* for a *cable* of 20 inches, of the firſt article of the firſt table; and thus of all the reſt.

Firſt TABLE.

1. *Inch.*	5.	9.
Cables of 21	Cables of 15	Cables of 14
of 20	of 14	of 13
of $14\frac{1}{2}$	of 9	of $12\frac{1}{2}$
of 10		of 12
of 9	6.	of 8
2. *Inch.*	Cables of 13	10.
Cables of 20	of 12	Cables of 12
of 19		of 12
of 13	7.	
of 9	Cables of 10	11.
of 8	of 9	Cables of 8
3. *Inch.*		of $7\frac{1}{2}$
Cables of 17	8.	of 6
of 16	Cables of 16	12.
of 12	of 15	Cables of 8
of 8	of 10	of 7
4.		of 6
Cables of 12		
of 16		
of 11		

1.	104 *lb.*		104 *lb.*
Sheet anchor	60 0 3	Stream anch.	39 0 3
Common anch.	56 0 1	Grapler	7 2 0
Stream anch.	55 0 0		
Kedge anch.	25 0 0	3.	
Grapler	7 0 2	Sheet anchor	35 3 3
2.		Common anch.	34 0 2
Sheet anchor	43 0 0	Stream anch.	31 2 7
Common anch.	40 0 5	Kedger	11 3 5

4.	104 *lb.*	9.	104 *lb.*
Sheet anchor	32 0 0	Sheet anchor	18 0 0
Common anch.	30 2 2	Common anch.	17 0 0
Stream anch.	27 0 0	Stream anch.	16 0 2
5.		Kedger	4 2 0
Sheet anchor	29 0 0	Grappler	2 2 0
Common anch.	25 0 0		
Stream anch.	23 3 2	10.	
Kedger.	9 0 0	Sheet anchor	11 0 0
Grapler	2 2 7	Common anch.	10 0 0
6.			
Sheet anchor.	28 0 0	11.	
Common anch.	27 0 0	Sheet anchor	7 0 0
7.		Common anch.	6 0 0
Sheet anchor	22 0 2	Stream anch.	5 2 0
Common anch.	11 0 0		
8.		12.	
Sheet anchor	27 0 0	Sheet anchor	5 0 2
Common anch	23 3 5	Common anch.	4 0 0
Stream anch.	23 0 0	Stream anch.	3 2 3

The *Sheet anchor* is uſed in a ſtorm; the *ſtream anchor* daily; and the *kedger* to tow a ſhip.

Ships are *caulked* and done over with *pitch* and *tar*, as well to preſerve them and make them laſt, as to hinder the water from running through the cracks and ſeams; this operation is made by means of tow, which, after it has been boiled and dried, either in the ſun or in an oven, is ſpun very looſe as big as the arm, and thruſt afterwards by the caulker into the ſeams of the ſhip.

The *graving* a ſhip is to be done over with, from underneath to the line of water, is a compoſition made of roſin, tallow, brimſtone, train oil, and pounded glaſs, to preſerve her from worms. When a ſhip is to make a long voyage ſhe is ſheathed, and the boards thereof are garniſhed with an almoſt infinite number of ſmall nails.

We'll now put a *ſhip* on the *ſtocks*.

1. Model, or *gabarit*.

When a ſhip-builder makes the *draught* or *model* of the conſtruction of a ſhip, he gives the name of firſt *model* or *chief rib*, to that *rib* which is to be placed under the main beam, and which anſwers to it; and even to the whole *model* raiſed perpendicularly over it.

The ſecond, third, and fourth *model*, fore or aft, are the other *models* raiſed on the other beams, fore or aft. Thoſe *models* are made with pieces of thin boards, to repreſent the length, breadth, and caliber of the members, and parts of a ſhip, when to be built and put on the ſtocks.

Expla-

Explanation of the first model.

FIGURE I.

1. *Ribs* of the first deck, which must have two thirds of the main stem.

2. *Futtocks*, of the upper deck; they must have the same thickness with the ribs of the first deck.

3. The *scupper holes bindings*, of the lower deck, are pieces of wood which running round the ship inside, serve to join it, and must be 19 inches broad, and 5 or six inches thick; those of the upper deck 17 inches broad, and $3\frac{1}{2}$ to 4 inches thick. Which is the decision of master ship-builders who have regulated the proportions of a ship of 137 feet in length.

4. *Scupper-holes*, are apertures made shelving, in the length of a piece of wood, placed on the side of the ship, for the running out of rain and sea-water. The *scupper-holes* of the upper-deck, *i. e.* the pieces of wood where the holes are made, must be four inches broad, and 4 thick; and the holes have 2 inches diameter, if the aperture be round, but it is most commonly made square-wise, and of several pieces. The *scupper-holes* of the lower deck must be 6 inches broad, and $5\frac{1}{2}$ inches thick; and the holes have 3 inches diameter.

5. The *the burdens of the deck*, which must be 17 inches broad, and $4\frac{1}{2}$ thick: we'll have occasion afterwards to regulate better their proportions.

6. The *side-planks*, which serve to cover the first gun-deck, are $2\frac{1}{2}$ inches thick.

7. The *bolster* of the carriage.

8. The *floor-timber* of the lower deck, which is a girder placed with several others, throughout the breadth of a ship, and rests on two ribs, by its two ends. Most carpenters give them $1\frac{1}{2}$ inch for every 10 feet of the length of the ship, taken from the stem to the stern-post; every 10 feet in length given them, likewise an inch of roundness arch-wise.

9. The *wheel* of the carriage.

10 The *alonge* of the *migrinier*, which is the first, or that joined with the *rib* and *knee* of the bottom.

11. The *knee of the bottom*, which is joined with the first *alonges* and *ribs*, they must have in their angle half the thickness of the stem.

2 MODEL, or *gabarit*.

FIGURE II.

1. The *keel*.

2. The *platform*, which begins at number 2, and ends at 2.

3. The *floor-timber*, which crosses over the keel, and over all the bottom.

4. The *lengthening* or *alonge*, which forms the breadth and depth of the ship.

5. The *ferre-bauquierre*, in which the beams are joined, in the shape of a swallow's tail. The *ferre-bauquierres* run all round the ship. They have sometimes half the thickness of the stem, taken inside; others give them two fifths of that same thickness.

6. The *vaigre* above the *scupper-holes binding*.

7. The *rib* of the first deck.

8. The *lowermost deck* between the flowers and the lower precinct.

9. The *flowers*: for the beauty of a *model*, the *flowers* must ascend and rise with a roundness agreeable to the sight, and well proportioned. The flowers are formed by the junction of the floor-timbers with the knees of the bottom.

10. The *side-planks* between the girts.

11. The *girts* with their jutting out.

12. The *transom* of the *viboard*, which makes the last and higher *girt* of the ship, and which is most like the other *girts*.

13. *Beams* of the upper deck.

14. A *strop* commonly placed on the binding, as the *alonges* are under it, to strengthen the ship which carry many cannon.

15. The *vaigres* of *empature* of the knees and floor-timbers.

16. The *vaigres* of the bottom, and placed under the first girts.

17. The *carline*, which is the biggest piece of wood employed in the hold of a ship; several of them are put end to end, and placed on all the ribs, and as they serve to tie them with the keel, they are often called *keelson*, or *false keel*.

18. The *carriage* of a ship gun.

19 *Planks* which serve to cover certain notches made in the floor-timbers, of which the bottom of the ship is composed; and those notches serve for the evacuation of the water, which is in the ship from the prow to the pumps.

20. The *jarlot* of the keel, where the *gabord* enters; it is a kind of notch made in the keel, in the stem, and in the stern-post of the ship, to introduce into it a small part of the side-planks, which cover the members of the ship.

21. The *line*, which hanging to the level of the biggest part of the ship, is found a foot distant from the lowermost deck, at the place where it ends, and where the flowers begin in descending, and that's the breadth of the biggest part of the ship.

FIGURE III.

Which represents in another manner the same pieces of the two preceding MODELS, *and shew better the roundness thereof.*

1. The *futtocks* under the *false beams*, placed at every

every 6 feet diſtance, under the firſt deck, to ſtrengthen the bottom of the ſhip. Theſe *falſe beams* are pieces of wood like to thoſe over which often a falſe deck is made; and where it has its greater height, a retrenchment is contrived, where the ſoldiers retire to repoſe themſelves and ſleep.

2. The *bindings* of the *ſcupper-holes*.
3. The *weight* or *burden* of the deck.
4. The *carline*.
5. The *futtocks* of the upper deck.
6. The *reverſe lengthenings*.
7. The *binding* of the *bauquierre*.
8. A *ſcaffold* on which the workmen place themſelves.
9. The *main ſtem* inſide

Figure IV.

Which ſhews diſtinctly and ſucceſſively the parts or members of a ſhip, which give it the length and depth it muſt have forwards.

1. The *carline*.
2. The *keel*.
3. The *gabords*, or firſt boards downwards which form the outward ſides of the ſhip. The row of boards which are placed above the *gabord* are called *ribord*.
4. The *vaigres* and *lengthenings*.
5. The *lowermoſt deck*.
6. The *floor timbers*.
7. The *knees* of the bottom.
8. The *ribs* which ſupport the deck.
9. The *beams* of the firſt deck.
10. The *girts* with their jutting out.
11. The *bindings* of the *bauquierres*.

Figure V.

Repreſents,

1. The *floor* or *cieling*.
2. The *weight* of the deck, which is thick and narrow boards notched, to put over the beams in the length of the ſhips, on each ſide, from fore to aft, at very near one third of the length of the ſhip.
3. The *flat ribs*.
4. The *lengthenings*.
5. The *futtocks*.
6. The *port holes*, placed bandwiſe on both ſides of the ſhip.
7. The *beams* of the ſecond deck.

Figure VI.

Shews diſtinctly and ſucceſſively the parts or members of a ſhip, which give it the breadth and depth it muſt have backwards.

1. The *carline*.
2. A *rib* placed backward and round inſide.
3. *Flat ribs*,
4. A *rib* half backward, it has leſs cavity than thoſe quite backwards.

Note, That we ſee in this *figure*, that the *flat ribs* are in the middle; that thoſe placed backward follow them; and thoſe quite backwards are placed at the extremities of the ſhip.

Figure VII.

Repreſents,

1. The *port-holes*, bandwiſe, on both ſides of the ſhip.
2. Two *port-holes* at the ſtern.
3. *Bands*, pieces of timber-work. There are ſeveral ſorts of them, and are placed in different parts of the ſhip, as well to join the members thereof, as to ſtrengthen and keep up the whole ſtructure.
4. The *futtocks*, which ſupport the deck.
5. The bindings of the *ſcupper-holes* of the lower deck, we have already obſerved, that they muſt be 19 inches broad, and 5 or 6 thick at the firſt deck.

Here follows a rule for the thickneſs of the *ſide planks*, mentioned in the above deſcribed *figures*.

The ſide planks of the bottom of a ſhip, from — *Feet.*	*Thickneſs. Feet in length, from the ſtem to the ſtern-poſt, muſt be*
40 to 60	2 *Inches thick.*
60 to 80	2½
80 to 100	3
100 to 120	3½
120 to 140	4
140 to 160	4½
160 to 170	4½

I'll explain here the two figures of the fore part of a man of war, repreſented in the plate of *Naval Architecture*; thoſe figures being cut in a manner, that the outſide parts which do not appear in one, are repreſented very diſtinctly in the other, and are marked with the ſame cyphers or letters, *viz.*

S. The *neck-piece* of the cutwater, which muſt have 27 feet in length, and 5 in breadth, to be proportioned to a man of war, which has 145 feet in length from the ſtem to the ſtern-poſt, 36 feet broad, and 15 deep.

R. R. The *futtocks* of the neck-piece. The needles of the cutwater comprized between the neck-piece and the yard-bearers, and which jut out much into the ſea, are here more rounded than they were formerly.

T. The *holes* or *faſtenings* of the tacks of the fore-maſt.

V. V. The *ſtem.*

W. The *keel.*

X. The hole thro' which paſſes the tack of the bowſprit.

P. The *hawſe holes.*

Q. Q. The *girts.*

O. O. The *ſide planks*, which are put two and two between the girts.

N. The *threſhold* of the port-hole, or lower *threſhold.*

M. The *valves* of the port-holes of the large battery. Large men of war have commonly three batteries.

L. The ſecond *battery* is placed above the lower, or at the middle deck; and the third on the upper deck. Each port-hole muſt have its *dragues* and its crane; which are big ropes, ſerving to approach, and draw back the cannon, and likewiſe to ſtop the recoil, ſo that a piece of cannon may not recoil, when it is fir'd, further than half deck.

F. K. *Embraſures* to level the cannon.

I. The *cadenes* of the ſhrowds, which are iron-chains, at the end whereof is placed a *ram's block* (g) to make the ſhrowds tight. They ſerve to ſo many other things, that for the rigging of a ſingle ſhip, we take moſt commonly 13 dozen of them.

E. E. The *yard bearers* 1, 2, 3. which are above the cutwater, the uppermoſt is 8 inches broad backwards, and $4\frac{1}{2}$ thick; 5 inches broad forwards, and $3\frac{1}{2}$ thick. The ſecond 6 inches broad, and $4\frac{1}{2}$ thick backwards; $4\frac{1}{2}$ broad, and $3\frac{1}{2}$ thick forward. The lowermoſt $6\frac{1}{2}$ broad, and 4 inches thick backward; and 5 inches broad forwards.

4. The door of the fore-caſtle.

1. 2. The ornaments of the uppermoſt part of the poop.

3. 5. Shewing the ſheathing of the boards, which make an end of covering the hind part of the ſhip, as far as the *platboard.*

Note, That here follows a more particular deſcription of ſeveral pieces or members of a ſhip, which have already been mentioned; beginning at the ſtern.

The *great block* of the *driſſe.*——It is a large ſquare piece of timber, placed upright on the *carline*, whence it riſes over the deck. At the upper end of that piece of wood, there are three or four ſpinning wheels of pullies on the ſame axle-tree, on which the great clew-lines paſs; the main block of clew lines ſerve to the main-yard.

The *main capſton*, 2. *Fig.* 17. is a wooden machine placed on the firſt gun deck, and which riſes 4 or 5 feet above the ſecond; it is called *double capſton*, becauſe it ſerves to raiſe the anchor, and for other uſes, which I'll mention, when I'll explain its figure.

The *little* or *ſimple capſton*, placed on the ſecond deck.

1. The *dogue* of *amure.* There is one on each ſide of the ſhip. It is a hole with a *taquet* inſide, and a frame outſide. One of thoſe holes is larboard of the ſhip, and the other ſtarboard, on the flat body at the head of the main-maſt, to tie the *couets* of the main-ſail. The diſtance between the etambraie of the main-maſt, and either of the *dogues* of *amure*, is equal to the length of the main beam.

3. *Chains* of the *ſhrowds.*

4. *Maſt*; it is a great tree, or a long piece of wood placed in a ſhip, to which the yards, ſails and tackles neceſſary for the ſailing of the ſhip, are faſtened.

5. *Chouquet.*

6. It is a triangular piece of wood placed on the end of the ſtays, and which join them with the ſtern.

7. *Taquet* of the key of the ſtays. It is a piece of timber, placed under the key of the ſtays, between the counter-fort, and the counter-ſtern-poſt.

8. The *ladder of the poop*; which is made of cord, and hangs at the ſtern of the ſhip, for the convenience of the people of the ſhallop, and to make uſe of it in a tempeſt.

FIGURE XI.

Shews,

1. A ſimple pulley; which is a *muffle* where there is only a ſingle pulley.

2. A *crane pulley*, which is a double muffle, where there are ſometimes two pullies over one another, and ſometimes even four.

3. *Pullies of caliornes*, which are pullies with two or three wheels on the ſame axle-tree.

4. *Common pullies*; which is a round body made of wood or metal, in form of a plate, with a hollow all round it, for a rope to run round. The pulley is ſet in what's called a *ſcarf* or *muffle*; and by that word *pulley* is underſtood the whole together, *viz.* the *ſcarf*, the *pulley*, the *wheel*, and the *axle-tree.*

5. *Cut*, or *dented pulley*, is a pully which has its ſcarf ſloping on one ſide, to run the bow-line into it, when it is neceſſary to hale it.

6. *Hawſe-block*, is a large ſquare piece of timber, placed upright on the carline, whence it riſes over deck. At the upper end of that piece of timber, there are three or four wheels of pullies on the ſame axle-tree, over which the great driſſes run.

7. The *block* of the *driſſe* of the mizen maſt, the pullies whereof muſt be eight inches broad, with proportionable cordages.

8. The *ſcuttle*: it is a kind of little platform, ſupported by wooden bars, and which runs, in jutting out, round the cap of the maſt: though moſt commonly

commonly the largeſt ſhips have but four *ſcuttles*, viz. the main-ſcuttle, the fore-maſt-ſcuttle, that of the bowſprit, and that of the mizen, and there are but bars at the other maſts, thoſe bars are notwithſtanding called *ſcuttles*. The *ſcuttles* ſerve for working the ſhip, wherefore the ſailors go up to them. They ſerve likewiſe to faſten the ſtays, ſhrowds, and ſeveral other cordages. A ſailor is kept there in centry, that he may ſee at a greater diſtance.

The *ſixteenth figure* repreſents,—1. The *etambraie* of the main-maſt. The *etambraies* are round holes made in the decks of a ſhip, to paſs the maſts thro' them, or they are two large pieces of wood which embrace a round hole made in the deck, through which the maſt runs, the better to ſtrengthen the deck in that place, and keep the maſt more ſteady.

2. The *etambraie* of the fore-maſt.

3. The *etambraie* of the *capſton*.

4. The *pump*.

5. The iron, or wooden *rod* of the pump.—It holds the apparatus.

6. The *girt of viboard*, is a girt a little ſmaller than the others, which runs all along the ſhip upwards.

7. The *girts* are long pieces of wood, put in divers places a-top of the ribs of a ſhip, as well for ornament as neceſſity. The chief of them are over the *acaſtillages* at breaſt-high. There are likewiſe ſome of them on the pediment of both caſtles.

The *twelfth figure* ſhews,—1, 2. The figures of the *bits*.

1. The firſt ſhews the *bits*, ſuch as they are ſeen backwards; *b b*, the *pillars* or the *bits*; *c c*, the head of the pillars; *d d*, the holes which ſerve for the large iron pegs when the cable is on the *bits* to ſtop it, and hinder it from ſpinning; *e e*, the bowſprit; *g g*, the deck; *h h*, the head of the bolſter, which is of deal.

This firſt figure of the *bits* has its proportions, that it ſhould not riſe above the firſt deck. But if it was to be carried as far as the ſecond, the pillars ſhould be kept longer downwards.

The ſecond figure ſhews the bits on the fore part of the ſhip, the better to diſcover the futtocks which do not appear at the ſtern; *b b* the upper branches of the futtocks which extend over the deck, as far as the head of the bolſter; *c c*, the lower branches of the futtocks, which cannot be made too long, and can be extended as far as the guerlandes, which are thoſe large pieces of carpenter-work bent, and placed ſquare-wiſe on the ſtem, above, and under the hawſe-holes, to form the joining of the fore part of the ſhip, and keep up the ſide-planks; *d d d d*, bolts with rings which run through the ribs and beams, and are faſtened with pins.

3. The *Pillars of the bits*.

4. *Hawſe-hole*. Commonly there are two *hawſe-holes*, one on each ſide of the ſtem; and ſometimes four, two on each ſide the fore part of the ſhip, ſtarboard and larboard of the ſtem. In men of war which have two gun-decks the *hawſe-holes* are pierced under the firſt or lower deck.

5. The *great level*.

The *fifteenth figure* ſhews,—1. The *architrave*, *epiſtyle*, which is a piece of timber placed on columns inſtead of arcade, and is the firſt and principal, which ſupport the others.

2. *Bars* of the capſton, are certain ſquare pieces of wood, ſerving to turn the capſton round.

3. The *carline*. I have ſaid already, that it is the longeſt and biggeſt piece of wood, employ'd in the hold of a ſhip.

4. The *girts*, already mentioned, are placed parallel one to the other. The ſailors find a conveniency in them when they want to get into the ſhip to clean it.

5. *Counter-girts* are thoſe placed over the thillar-tranſum.

6. The *great carline*, or *zarline* of the main-maſt.

7. The *carline* of the foot of the fore-maſt.

8. The *carline* of the mizen-maſt.

9. The *carline* of the capſton.

10. The *ſtraps*, which are pieces placed over the binding, as the *alonges* are under it, to ſtrengthen large ſhips which carry many cannon. The larger ſhips which have two rows of port-holes want double ſtraps backwards, and ſtill more under the fore-caſtle, becauſe of the anchors, which are drawn up there, and ſhake that part much.

The *fourteenth figure* repreſents,—1. The thillar-tranſum, already mentioned.

2, 3. *Porques* of the bottom, ſituated about the middle of the carline, and are leſs bent, and flatter than the other *porques*, becauſe the bottom of the ſhip is flatter about the middle of the *carline*.

4. *Bindings* of the *ſcupper-holes*.

5. *Flat boards*, placed over the ends of the reverſe lengthening cloſe to the *girts*.

6. *Threſholds* of a port-hole, or lower threſhold, is a board which being put over the lower part of the port-hole, covers the thickneſs of the ſides, and prevents the water from rotting the members of the ſhip.

7. Some call likewiſe, *threſholds*, the croſs piece of timber, which reſts on the two upright beams, and into which enters the iron work.

8. The *vaigres* of *empature* of the floor-timbers and *knees*, are thoſe which follow the *vaigres* of the bottom, and are riſen above it, to form the roundneſs on both ſides.

9. The *fargues* are boards riſen on that part of the

the *flat board* called the *bule*, to ſerve inſtead of guard-corps, the better to defend the deck, and to ſteal from the ſight of the enemy what paſſes on deck. The *belle*, or *embelle*, is that part of the upper deck which runs between the ſhrowds, of the fore-maſt and the main-ſhrowds, and which having its ſide leſs riſen than that of the other parts of the ſhip fore and aft, leave that part of the deck almoſt quite open at its flanks. It is then to cover that place that the *fargues* are uſed. They are took off when the fight is over, as well as the guard-corps, which are mates, or textures made of ropes, and placed on the upper ſides of men of war, to ſhelter ſoldiers againſt the muſketry of the enemies.

11. The gallow of the lever which ſerves to draw the water out of the pump.

We have ſeen in the preceding figures, the application of the models made to ſhew the length, breadth, and caliber of the members and parts of a ſhip, when it is to be built, to be put on the ſtocks; and in a condition to be launched, which is done in the following manner.

To place well a keel on the ſtocks (*Fig* 7.) the *ſtocks* muſt be placed at 6 feet diſtant from one another, taking care that the middle of the *keel* ſhould reſt directly on the middle of the *ſtocks*. The bigger tins deſigned to keep the *keel* almoſt in an equilibrium when the ſhip is launched, muſt be placed at 5 feet of the length of *keel*, taking it backwards, and from the heel of the *keel*. The *tins* more backward need no wedges, becauſe as ſoon as the ſhip leans a little forward, it reſts leſs on thoſe ſtocks, and they fall of themſelves; but wedges muſt be put at all the other ſtocks, from the biggeſt forwards. Some carpenters make the fore-maſt ſtock, which is under the ſtem, of a wood very eaſy to ſplit, and to launch the ſhip, they dig up a little of the earth round the ſtock, and under it, ſo that it ſinks a little, and then breaks it in pieces.

When the *keel* is well placed on its ſtock, a line is drawn through its middle, from fore to aft, to ſee if it be not arched. Moſt carpenters make it arch by 6 or 8 inches underneath, according to its length, pretending that it ſtraitens again when it is in the water, becauſe ſhips being much narrower at their extremity than in their body, and conſequently leſs ſupported there by the water, the extremities ſeldom fail ſinking a little at firſt, and afterwards, when the ſhip grows old, they continue to ſink a little by degrees, and the *keel* bends inſide, which produces a very diſagreeable effect, and ſometimes a dangerous one. In placing the *keel* on the ſtock, care is taken to keep it higher backwards, and as high as is neceſſary to launch eaſily the ſhip to the water, and before the *tins* are put under the *keel*, it would be very proper to make a bed of good boards 10 or 12 inches broad, or more, to place the *tins* upon it, rather than on the ground. All this may be eaſily underſtood, in examining *figure* 7. of the plate, where the letter A ſhews the ſhip on the *ſtocks*, with the following circumſtances.

1. A ſcaffold made ſlanting for the workmen to go in, and come out of the ſhip.

2. An aperture left for the paſſage into the ſhip, of the biggeſt pieces of timber, which muſt ſerve for its conſtruction.

3. Pieces of timber diſpoſed at a level, and ſupported by other perpendicular ones, in a dock, *Dutch* faſhion, or the ground even with the water, to facilitate the launching of the ſhip, in the manner repreſented under the letter B.

4. *Tins* placed on the ground, or on boards to ſupport the *keel*.

5. The ſtocks, or bed where the tins and ſhip reſt.

6. *Wedges* greaſed, and drove under the *keel*.

7. *Coites*, or long pieces of timber placed parallel under the ſhip, to carry it when taken off the ſtocks, in order to launch it to the water. The *French* make uſe of two indented pieces of wood, which they call *colombiers*, and which go to the water along with the ſhip; and when the ſhip begins to float, the *colombiers*, which are tied to it with ropes, floating likewiſe, are withdrawn. But among the *Dutch* the *coites* remain in their place, and the ſhip ſliding over them, goes alone to the water. The *Dutch* have this particular beſides, that they put each ſide on the coites, the wedges which ſerve to make the ſhip ſlide on the coites, and launch it.

8. The *caliome*, and rope to ſtop the ſhip and draw it forwards and backwards, as neceſſity requires it. Laſtly, it is ſeen in the figure B, how far the conſtruction of a ſhip is advanced when it is launched. It is perfected afterwards by erecting a ſcaffold, which reaches from the ſtern of the ſhip to the ſhore, where there are quays made for that uſe.

The pit, pond, or creek, where ſhips are built or repaired, is called *dock*.

To *careen* a ſhip, is to lay it on one ſide, to caulk, ſtop up leaks, refit or trim the other ſide.

This operation of *careening* is ſeen, *Fig*. 8. *Nav. Arch.* in thoſe figures A ſhews a ſhip which is careened on the ſtarboard ſide; and B, a ſhip careened on the larboard ſide.

C, Heating made with ſmall wood, while the careen is given to the ſhip. The heat muſt not be ſpared.

D, The tar wherewith the wood of the ſhip,

and the cordages are imbibed, that they may reſiſt the water, wind, and heat of the ſun.

E, That tripod or candleſtick, which are three ſtakes driven very far into the ground, in the middle whereof is a fourth, placed like a candle in a candleſtick. It is called ſtool and tripod, becauſe of its likeneſs to the ſeats with three feet, uſed in *Holland* by moſt workmen. To this are faſtened the ropes which ſerve to ſupport the ſhips when they are put on their ſides to be careened; to which are faſtened likewiſe the *atrapes*, which are large ropes, to hinder a ſhip from lying too much on its ſide, while ſhe is in careen.

A man of war thus entirely finiſhed, muſt be fitted with two *boats*, one called the *ſhalop*, or *long-boat*, and the other the *canoe*.

The *ſhalop*, or *long-boat*, ſerves to carry people on board the ſhip, or on ſhore, or from one ſhip to another. It ſerves likewiſe to carry the towing-anchor, when it muſt be caſt. To carry on board the munitions and proviſions, the ballaſt, and other heavy burthens, to ſave the crew and cargo in caſe of a ſhipwreck, or any other misfortune at ſea, and to a great number of other particular uſes. In plate of *Naval Architecture*, Fig. 9. is ſeen a *ſhalop* turned upſide down, to ſhew from the top the ſituation and order of its inward parts, *viz.*

A, The *ribs*.

B, The *knees* of the bottom.

C, The *carlines*.

D, The *ſerrebanquierres*

E, The benches where the rowers ſit.

F, The *deck*, and the bench of the fore part of the *ſhalop*.

G, The benches joined round the hind part inſide, for the conveniency of thoſe who are in it.

H, The *floor*, or bottom of the *ſhalop*.

I, The *taquets* with their *echomes*, to preſerve the boards againſt the rubbing of the oar. In their ſtead is placed, in ſmaller boats, two *tolets*, which are ſmall wooden pegs to place the oar between.

K, The *freeze* and *girt* of the viboard.

M M, The *crowning* of the *ſhalop*.

N N, Small *futtocks* to keep the benches of fore and aft ſteady.

O O, A rool of defence, to defend the ſtem from ſtriking againſt large veſſels.

P. The pegs to hang the *ſoals* or *derives*.

Q, *Hole* in the *carline*, with a notch in the bench to place the maſt.

The *canoe*, is a kind of ſmall ſhalop, deſigned for the ſame uſes as the long-boat. The tenth figure of the plate ſhews a *canoe* turned upſide-down like the *ſhalop*, wherein are repreſented all the inſide parts thereof, and diſtinguiſhed by figures. The figures which are not viſible in the canoe turned upſide-down, are eaſily ſeen in the perpendicular ſection of the ſame *canoe*, viz.

1. The fore part of the *canoe*.
2. The hind part.
3. The ribs.
4. The knees of the bottom.
5. The carline.
6. The ſerrebanquierre.
7. The board.
8. The taquets with their echomes.
9. Pieces of wood placed behind the *careen*, to place the oar to row the canoe, either to the ſhip or to ſhore.
10. The deck and bench of the fore part of the canoe.
11. The *cajute*, and benches of the ſtern.
12. *Taquets* to faſten the ſoals, when the wind ſerves.
13 The hole to place the maſt.
14. The futtocks to ſtrengthen the benches fore and aft.
15. The virevaut.
16. The hatch.
17. 18. The length of the canoe, which is moſt commonly as much as the breadth of the ſhip to which it is to ſerve.

In *England* and *Holland* they have a kind of ſmall veſſel, called *yacht*. There are ſome of thoſe *yachts* which are 66 feet long, 19 broad, and 6 deep, under the ſcupper-holes.

On the *Mediterranean*, the *French*, *Italians*, *Spaniards*, &c. have *galleys*.

A Galley is a low built veſſel, going both with oars and ſails.

Here follows a deſcription of the principal parts of a *galley*, viz.

The *rudder*, called by the Italians *temone*, is ſuſpended to the ſtern with two hooks, like in other veſſels.

The *main maſt* is 90 palms long; big at the bottom 2 palms, and a-top $1\frac{1}{2}$. The *Italians* call it *albero maeſtro*.

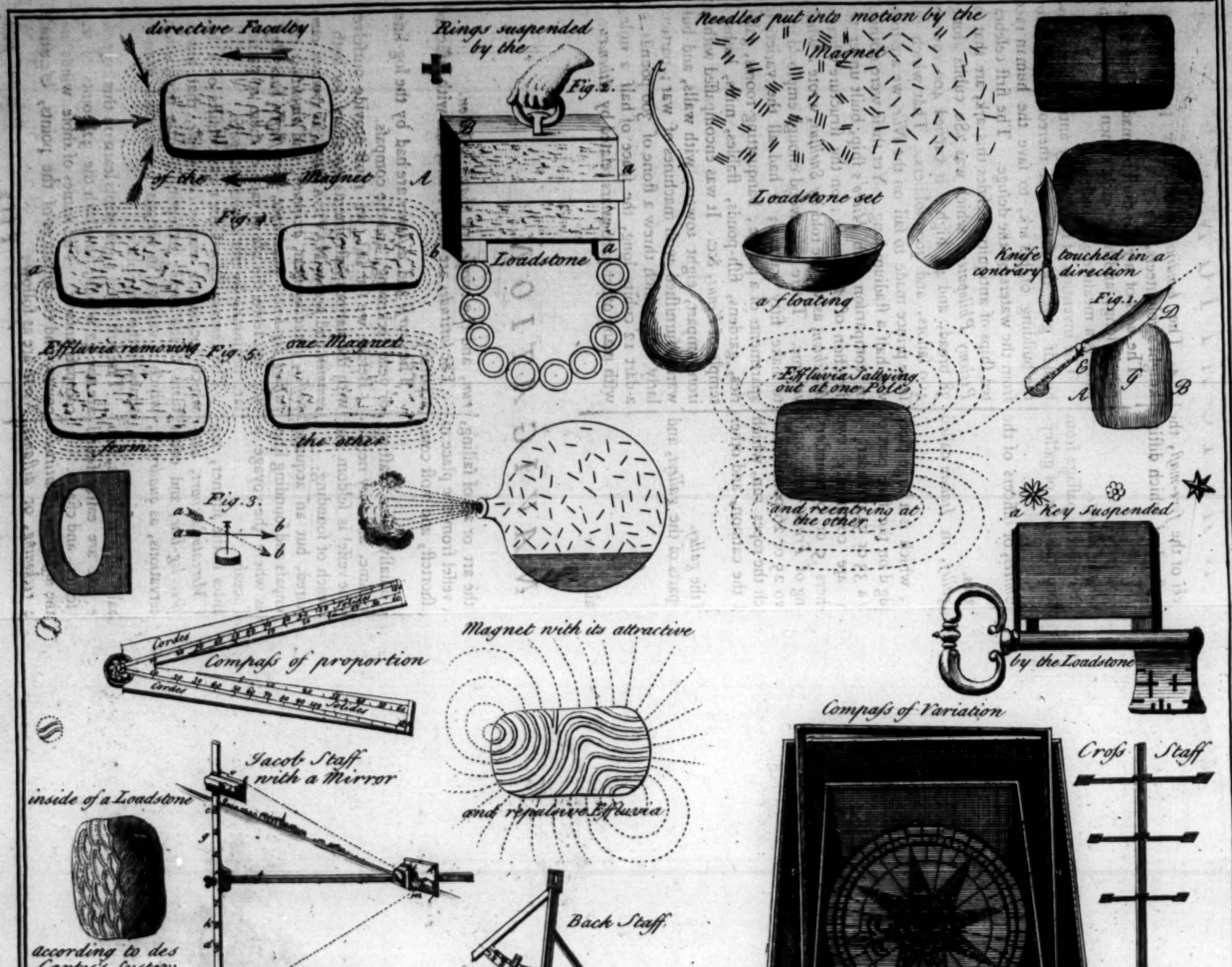
The *fore-maſt*, called by the Levantines *trinquet*, and the Italians *albero de trenchetto*, is 54 palms long, big at the bottom, $1\frac{1}{4}$, a-top $\frac{2}{3}$ of a palm.

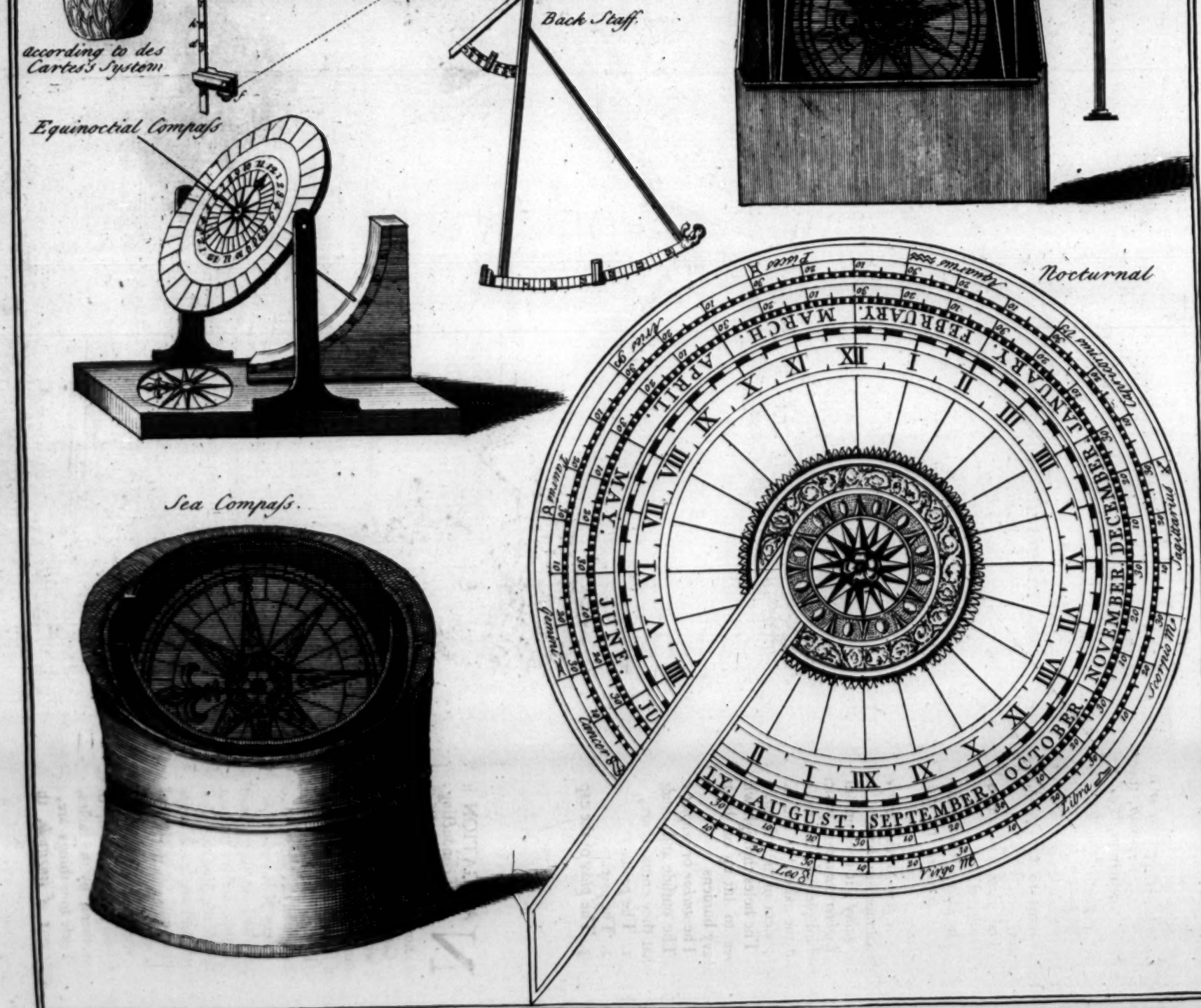
The *main yard* is 112 palms long, $\frac{1}{8}$ big at the lower end, and $\frac{7}{12}$ at the upper end. The *yard* of the fore-maſt is leſs, according to the proportion which is between both maſts, or from 90 to 54.

The *main ſail* is by the *Italians* called *antenna*.

The *gabier*, is the ſailor who ſtands centry on the ſcuttle, called *gabie* on the *Mediterranean*. There are the *great flag*, the *bannicre*, the *flag of*

MAGNET and NAVIGATION.




according to des Cartes's System
Equinoctial Compass
Back Staff
Nocturnal
Sea Compass.
JANUARY. FEBRUARY. MARCH. APRIL. MAY. JUNE.
JULY. AUGUST. SEPTEMBER. OCTOBER. NOVEMBER. DECEMBER.

the trinquet, the *weather cocks* of the *fore-maſt*, the *banner* of the *fore-maſt*, the *ſtandard*, which diſtinguiſhes the nation, &c.

The *place* of the ſteerer.

The *place* of the captain in the *dunette*.

The *courſer*, or *corſia*, which is the paſſage from the prow to the poop, thro' the rows of galley-ſlaves.

The *place* of the two *comites*, or officers of the galley-ſlaves.

The *place* of the trumpeters.

The *cutwater* of the *galley*, in *Italian* called *ſperone*.

The *place* of the *courſer*, which is a large piece of cannon in battery, lodg'd on the fore part of the *galley*; it is commonly a 33 or 34 pounder.

Lighter cannons, which are commonly two baſtard pieces, and two others 5 or 6 pounders. But the galleys of the King of *France* carry only at preſent in their ſtead, two 25 or 26 pounders.

The holes through which the ropes run, which ſerve to lift up on board the cannon, and other heavy burdens.

The *anchor* or *grapler* of the *galley*.

The outſide and inſide parts of the *galleys*, and what they contain, are,

1. The *prow*.
2. The *poop*.
3. The *place* of the captain.
4. The *bandins*, which are places for the knight's volunteers.

The *oars* of a *galley* muſt be made of beech, 48 palms long, and have each 5 men to row. The palm is a meaſure of 9 inches.

The invention of ſhips is very antient, ſince God himſelf gave the firſt model thereof to *Noah*, for the building of his ark, to ſave the human race from the waters of the deluge. The firſt celebrated ſhips of antiquity, beſides this ark, are that of *Ptolemy Philopater*, which was 280 cubits long, 38 broad, and 48 high; it carried 400 rowers, 400 ſailors, and 3000 ſoldiers. That which the ſame prince made to ſail on the *Nile*, we are told, was half a ſtadium long. Yet theſe were nothing in compariſon with *Hiero*'s ſhip, built under the direction of *Archimedes*; on the ſtructure whereof *Moſchion*, as we are told by *Snellius*, wrote a whole volume. There was wood enough employ'd in it to make fifty galleys; it had all the variety of apartments of a palace; banquetting-rooms, galleries, gardens, fiſh-ponds, ſtables, mills, baths, a temple of *Venus*, &c. It was encompaſſed with an iron rampart, eight towers, with walls, and bulwarks, furniſhed with machines of war; particularly one, which threw a ſtone of 300 pounds, or a dart 12 cubits long, the ſpace of half a mile; with many other particulars related by *Athenæus*.

NAVIGATION.

NAVIGATION is the art or act of ſailing, or of conducting a veſſel from one place to another, the ſafeſt, ſhorteſt, and moſt commodious way.

Common NAVIGATION, uſually called coaſting, is when the ports are on the ſame, and very neighbouring coaſts; and where the veſſel is ſeldom out of ſight of land, or out of reach of ſounding.

In this, little elſe is required, but an acquaintance with the land, the compaſs and ſounding line.

Proper NAVIGATION, is where the voyage is long, and out in the main ocean.

In this, beſides the requiſites in the former, are likewiſe required the uſe of *Mercator's chart*, *azimuth*, and *amplitude compaſſes*, *log-line*, and other inſtruments for celeſtial obſervations, as *quadrants*, *fore-ſtaffs*, &c.

Navigation turns principally on four things, two whereof being known, the reſt are eaſily found from them, by the tables, ſcales, and charts.

Theſe four things are, the *difference of latitude*, *difference of longitude*, the *reckoning*, or *diſtance run*, and the *courſe*, or *rhamb ſailed on*.

The *latitudes* are eaſily found, and with ſufficient accuracy.

The *courſe* and *diſtance* are had by the log-line, or dead reckoning, and the compaſs.

Before we ſet ſail, we muſt provide ourſelves with the various inſtruments neceſſary for both a *common* and *proper* NAVIGATION, as *common compaſſes*, *ſounding-lines*, *azimuth*, and *amplitude compaſſes*, *log-lines*, *quadrants*, *fore-ſtaffs*, *back-ſtaffs*, &c. and learn the uſe of each of them in particular, beginning by the *common compaſs*.

The *common* SEA-COMPASS conſiſts of a box which includes a *magnetical needle*, that always turns to the *north*; excepting a little declination, which is various in various places, and even at times in the ſame place.

The firſt thing pupil pilots learn on this *compaſs*, are the 32 winds; to which the 32 points of the compaſs anſwer. The names of thoſe winds and points, and the diſtances of the points, &c. from *North* are as follow:

		From the North.
1. North,	0°	0′
2. North by East	11	15
3. North-North-East	22	30
4. North-East by North	33	45
5. *North-East*	45	
6. North-East by East	56	15
7. East-North-East	67	30
8. East by North	78	45
	From the East.	
9. East,	0°	0′
10. East by South	11	15
11. East-South-East	22	30
12. South-East by East	33	45
13. *South-East*	45	
14. South-East by South	56	15
15. South-South-East	67	30
16. South by East	78	45
	From the South.	
17. South,	0°	0′
18. South by West	11	15
19. South-South-West	22	30
20. South-West by South	33	45
21. *South-West*	45	
22. South-West by West	56	15
23. West-South-West	67	30
24. West by South.	78	45
	From the West.	
25. West,	0°	0′
26. West by North	11	15
27. West-North-West	22	30
28. North-West by West	33	45
29. *North-West*	45	
30. North-West by North	56	15
31. North-North-West	67	30
32. North by West	78	45

Next, they learn the *use of the compass*, which is *obvious:* For the course a ship is to sail in, being known by the chart; and the *compass* so placed, as that the two parallel sides of the square bore be disposed according to the length of the ship, *i. e.* parallel to a line drawn from the head to the stern, the rudder is to be directed accordingly; *v. gr.* if the course be found on the chart, between the south-west and south-south-west, *i. e.* south-west ¼ to the south; turn the stern, so that a line from the south-west, ¼ south, exactly answers the mark on the middle of the side of the bore. This is all that is required.

The *magnet* or *loadstone* as it is commonly called, is a sort of iron-stone, found in iron mines, of the colour, but harder and more ponderous than iron.

Its natural property is to attract iron; and this attractive property is conveyed by rubbing the stone upon steel or iron to the metal also.

But its most useful faculty is its direction always to the north point of the globe.

To account for all the phænomena of the *magnet*, according to both its *attractive* and *directive faculty*, several hypotheses have been invented at different times, and by divers philosophers, tho' none of them has been found satisfactory yet.

Cardan attributes the *directive* faculty of the *magnet* to the polar star: the university of *Conimbre*, to some part of the heavens, not very distant from the pole: the common scholasticks to an occult quality, which God wills *should be the subject of our surprize, but above our apprehension.* And the modern philosophers, have recourse to certain substantial effluvia flowing from the earth; which last opinion is the most probable; tho' in the particular explication of their several opinions, a great number of difficulties occur, which are not very easily resolved.

Des Cartes explains the *magnetical* virtue, by the striated or channelled matter, which he supposes circulating round the earth, and imagines this hypothesis very easy, and very proper to explain the phænomena of the *magnet*. But several philosophers cannot believe that it is possible, that either the necklace of the striated matter, or the channels or small pipes in which they are moved, can always retain their striated figure, without the prominences of the channels being wore off at last. For how is it possible, say they, that a continual friction should not wear off the channels: and how can the prominent parts of the beads be so aptly received into the striated receptacles dug in the channels, as never to stop in them, nor retard the motion of the succeeding holes; and be moved with no less celerity, than if they were carried round their axis with a direct motion?

The *directive faculty* of the *magnet* must be taken from the substantial effluvia entring, by a perpetual circulation, one pole of the earth, and coming out at the other; since by those substantial effluvia, entring by a perpetual circulation one pole of the earth, and coming out at the other, the direction of the *magnet* towards the poles of the earth is rightly understood; those *effluvia* being again moved through the same meatus they had formed to themselves in the mine. And this is confirmed not only by the phænomena of the *magnet* itself, but likewise by those of the iron, the nature whereof is much like that of the *magnet*.

For, 1. Iron rods which have been a long time fixed on the earth in a perpendicular manner acquire a *magnetick* virtue, whereby they direct themselves towards the poles of the world. When any iron bar standing, for a considerable time, perpendicularly in the fire, has a *magnetick* power; and when applied to the needle of

of a ſea-compaſs, attracts it to itſelf, on one part, and repulſes it on the other, as it happens in the *magnet*; which cannot be underſtood unleſs by the ſubſtantial effluvia, which flowing from the earth incline the ſmall fibres of the iron on that part, towards which they are moved. For that power is eaſier communicated to a hot iron, and a little ſoftened, than when it is cold and hard.

2. We can be perſuaded that the *magnet* borrows its *attractive faculty* from the earth, by the *inclination of the needle of a ſea compaſs*. For if the needle, which is placed in an equilibrium in the box of the compaſs, be touched by the *magnet*, preſently the part thereof, directed towards the north, beyond the equinoctial circle, in the northern climates is depreſſed, and the oppoſite part raiſed; becauſe the rays of the *magnetick* matter flowing from the earth, and penetrating the needle at its northern part or pole, are bowed archwiſe, as they are ſeen towards the poles *a*, *b*, fig. 3. in the *magnet* plate, whence they force that part to deſcend a little, therefore the mariners commonly affix wax to the other part, to keep the needle on a level.

But if the ſame mariners come under the equator, where the rays of the *magnetick* matter are carried in an almoſt direct line, as it can be ſeen towards the middle of the *magnet*, *a*, *b*, *Fig.* 3. *ib.* the wax muſt be taken off, and both parts of the needle will mutually keep one another in an equilibrium. Laſtly, if they paſs beyond the equator, the ſouthern part of the ſame needle, which before tended upwards, will begin to incline downwards, or be depreſſed, and the wax ſhall be affixed to the other part; from which experiment it is very well inferred, that the *directive power* of the *magnet* is to be attributed to the effluvia flowing from the earth.

3. The *magnet* not only adapts itſelf to the ſituation of the earth, but muſt alſo be conceived as a certain *terella*, or ſmall earth, having its poles, equator, and meridians, according to Dr. *Gilbert*'s ſentiment. For it has its vortex or atmoſphere, which the farther it goes the weaker it is; which vortex appears manifeſtly in iron-filings, ſtrewed round the *magnet*; for thoſe filings are ſoon ſeen to diſpoſe themſelves in the form of an orb, from one pole to the other, *viz.* from the pole *a*, ſouthern, to the pole *b*, northern, *Fig.* 3. *ib.*

But as the *magnetick* ſubſtance enters through one pole of the *magnet*, and comes out at the other pole; if the northern, or pole of ingreſs of one *magnet*, be turn'd towards the ſouthern or pole of egreſs of another *magnet*; the matter which flows from the one, will eaſily enter the other; whence the iron-filings between both will be directed in right lines, *v. gr.* if the pole *a*, or ſouthern of one *magnet*, Fig. 4. *ib.* be turned towards the pole *b*, northern of another *magnet*, the iron-filings thrown between both, will be ſoon directed in right lines, and to form one and the ſame vortex, around both *magnets*.

But if the two poles, which mutually regard one another, are both poles of ingreſs or poles of egreſs, or both northern or ſouthern, *Fig.* 5. *ib.* then the *magnetick* effluvia will form two vortices, and remove one *magnet* from the other.

When the *magnet* is armed at both poles with poliſhed ſteel, as *Fig.* 2. then the magnetick effluvia flow with a greater facility towards the pole, *v. g.* the northern A, through the ſteel between A and *a*, than through the air. Likewiſe on the other part, it is eaſier moved between B and *b*, than in the air, and therefore form a vortex, whereby iron-rings, diſpoſed in a ſemi-circle, are ſuſpended. Whence, if in lieu of rings a piece of iron be applied to the two extremities of the ſteel, *viz.* *a* and *b*, that iron will be ſuſtained by the force of both poles; whereas if it was not armed, it would only be ſuſtained by one, *viz.* either the northern or ſouthern: wherefore the magnetick virtue acquires a conſiderable increaſe by the *magnet* being armed. But if the ſteel wherewith the *magnet* is armed be ruſty, ſo as to hinder the magnetick matter moving thro' it with eaſe, then the magnetick virtue acquires but little increaſe. When a piece of paper is put between the armature, and the iron which is to be attracted, the paper hinders the *magnet* from having more virtue than if it was not armed; becauſe it does not touch the iron with more parts than if it was not armed.

The *navigator* having been well informed of the nature and properties of the loadſtone, and the uſe of the compaſs, is to apply himſelf diligently to the ſtudy of *charts* and other inſtruments.

In common navigation nothing is wanted but the *compaſs* and *ſounding-line*.

A CHART, or SEA-CHART, is a hydrophical map; or a projection of ſome part of the ſea in plans, for the uſe of *Navigation*.

There are three kinds of *ſea-charts*, viz. *plain charts*, reduced, or *Mercator's charts*, and *globular charts*.

Plain charts are thoſe wherein the meridians and parallels are exhibited by right lines parallel to each other.

Theſe *plain charts* are made, 1. By drawing a right-line, and dividing it into as many equal parts as there are degrees of latitude in the portion of the ſea to be repreſented. 2. Another line is added to it, at right angles, which muſt be divided into as many parts, and thoſe equal to one another, and

to

to the former, as there are degrees of longitude in the portion of the ſea to be repreſented. 3. The parallelogram muſt be compleated, and its area reſolved into little ſquares; then right-lines parallel to the two firſt will be meridians, and the others parallel. 4. The coaſt, iſlands, ſands, rocks, *&c.* muſt be inſerted in this *chart*, from a table of longitudes and latitudes, in the ſame manner as it is done in maps.

Hence, 1. The latitude and longitude of a ſhip being given, her place is eaſily exhibited in the *chart*. 2. The places to and from which the ſhip ſails, being given in a map, the right-line drawn from one to the other, makes, with the meridian, an angle equal to the inclination of the rhumb; and ſince the parts intercepted between equidiſtant parallels are equal, and the inclination of the right-line (drawn from one place to the other) to all the meridians or right-lines parallel to the firſt right-line, is the ſame; the right-line drawn from one place to the other truly repreſents the rhumb. After the ſame manner may be ſhewn, that this *chart* exhibits miles of longitude truly.

A Sounding-line is a line and plummet uſed in *navigation*, to try the depth of the water, and the quality of the bottom.

There are two kinds of *lines* occaſionally uſed in *ſounding* the ſea; the *ſounding-line*, and the *deep ſea line*.

The *ſounding line* is the thickeſt and ſhorteſt, as not exceeding 20 fathoms in length; and marked at two, three, and four fathoms, with a piece of black leather between the ſtrands; and at five with a piece of white leather.

The ſounding-line may be uſed when the ſhip is under ſail, which the *deep ſea-line* cannot. The plummet is uſually in form of a nine-pin, and weighs 18 pounds; the end is frequently greaſed, to try whether the ground be ſandy or rocky; and to diſcover in what degree of latitude the ſhip is, when a pilot thinks himſelf near a coaſt, and could not take any obſervation for ſeveral days before; for ſeveral coaſts are diſcovered, either by the quality, or colour of the bottom near them.—Near banks, ſhores, *&c.* they are to be ſounding continually.

Dr. *Hook* has invented a manner of *ſounding* the depth of the deepeſt ſea without any line, only by a wooden globe, lighter than water, to which, at a little diſtance, is a piece of lead or ſtone fixed, by means of a ſpringing wire in the firſt, fitted into a ſtaple in the ſecond. The whole being let gently down with the ſtone or lead foremoſt, as ſoon as that arrives at the bottom, it will ſtop; but the ball by the impetus it has acquired in deſcending, will be carried a little lower after the weight is ſtopped; by which means the ſpringing wire will be enabled to fly back and diſtinguiſh itſelf, and reaſcend. By obſerving then the time of the ball's ſtay under water by a watch or pendulum, and the help of ſome tables, the depth of the ſea is found.

In ſome experiments made in the *Thames* with a maple globe, $5\frac{1}{3}$ inches in diameter, and weighing 4 pounds and a half, lin'd with pitch, and a conical weight 11 inches long, the ſharp end downwards; at the depth of 19 feet, there paſſed ſix ſeconds, and at the depth of 10 feet $3\frac{1}{2}$ ſeconds between the immerſion and emerſion of the ball. From theſe numbers given, the depth at any other ſtays, may be computed by the Rule of Three.

The inſtruments we muſt embark for *a proper navigation*, or what the *French* call, *un voiage du long cours*, are, as already obſerved, *Mercator's chart*, *azimuth*, and *amplitude compaſſes*, *log-lines*, and other inſtruments for celeſtial obſervations, as *quadrants*, *fore-ſtaffs*, *back-ſtaffs*, &c.

Mercator's Chart, is that wherein the meridians and parallels, are repreſented by parallel right-lines; but the degrees of the meridians are unequal, ſtill encreaſing as they approach the pole, in the ſame proportion as thoſe of the parallels decreaſe; by means whereof the ſame proportion is obſerved between them as on the globe.

This *chart* has its name from that of the author, who firſt propoſed it for uſe, and made the firſt *chart* of this projection, *N. Mercator:* but the thought was not originally his own, as having been hinted by *Ptolemy*, near 2000 years ago; and the *Engliſh* ſay, that the perfection thereof is owing to their countryman Mr. *Wright*, who firſt demonſtrated it, and ſhewed a ready way of conſtructing it, by enlarging the meridinal line by the continual addition of ſecants.

To ſail by means of *Mercator's chart*, the following obſervations are to be made.

I. *The longitude and latitude of two places given, to find the departure or miles of longitude, in* Mercator's *ſailing* (which we have already found in *plain ſailing*) the reduction whereof is much more commodiouſly performed in *Mercator's charts*; wherein the arch intercepted between the two meridians, is applied to an arch of the meridian intercepted between the two parallels; and the diſtance in their meaſures, gives the departure, or miles of longitude required.

II. *The longitude and latitude of two places, to and from which a ſhip is to ſail, being given, to find the rhumb to be ſailed on, and the diſtance to be run in* Mercator's *ſailing*.—1. The center of the mariner's

ner's compaſs is applied on the place ſailed from, on *Mercator's chart*, and ſo as that the north and ſouth line thereof be parallel to ſome of the meridians. 2. The rhumb of the compaſs is marked, wherein the place ſailed to is placed; for this is the rhumb to be ſailed on. 3. The ſame rhumb is likewiſe found by drawing a right line from the place ſailed from to that ſailed to; and with a protractor, finding the angles the rhumb makes with any meridian it cuts.

III. *The rhumb and diſtance ſailed being given; to find the longitude and latitude of the place arrived at, in* Mercator's *ſailing.*—1. The mariner's compaſs is placed on the *chart*, with the center over the place ſailed from; and the meridian, and north or ſouth line, parallel to the meridian thereof. 2. From the place ſailed from, a right line is drawn for the ſhip's courſe: then the diſtance is taken by parts, in parts of the meridian, and is ſet off upon the right line, then will C be the place the ſhip is arrived at; the longitude and latitude whereof are given by the *chart*.

To find it by the loxodromick tables.——1. Under the given rhumb, ſeek the diſtance anſwering to the latitude of the place ſailed from; and either add it to, or ſubſtract it from the given diſtance, as the latitude of the place ſailed to is greater, or leſs than that ſailed from. 2. Under the ſame rhumb, aſcend or deſcend further, till you meet with the diſtance corrected. 3. The latitude anſwering thereto in the firſt column, is the latitude of the place ſailed to. 4. From the ſecond column of the table, take the longitudes correſponding to the latitudes of the places ſailed to, and from. Their difference is the difference of longitude of the places ſailed to and from.

In *plain ſailing*, i. e. by *common charts*, the operation is conducted thus, 1. From the *data*, the difference of latitude of the two places is found; this difference added to the latitude of the place ſailed from, or ſubſtracted from the ſame, the ſum, or the remainder, leaves the latitude of the place ſailed to. 2. From the ſame, the departure muſt be found; and thence the latitude of the place ſailed to.

IV. *The latitudes of the places ſailed to and from, together with the rhumb ſailed in, being given; to find the diſtance and difference of latitudes, in* Mercator's *ſailing*—1. The compaſs is placed on the *chart* as in the preceding caſe; and from the place ſailed from, the rhumb line ſailed in is drawn, till it cuts the parallel of the given latitude. 2. The point of interſection will be the place arrived in. 3. Hence its longitude is eaſily found, and the diſtances.

By the tables. Take both the longitude and the diſtances, anſwering to the latitudes of the given places, out of the tables; then ſubſtract both the longitudes and the diſtances from each other. The firſt remainder is the difference of longitude, the latter the diſtance of the places.

The ſame operation in *plain ſailing*, is made by finding the diſtance from the difference of latitude and the rhumb given; and from the ſame data the departure. This converted into degrees of a great circle, exhibits the difference of longitudes ſought.

V. *The latitudes of the places ſailed from and to, with the diſtance given; to find the rhumb, and the difference of longitude, in* Mercator's *ſailing*; the parallel the ſhip arrives at, is drawn on the map; and the diſtance run reduced into parts proportional to the degrees of the map.

By the tables; ſubſtract the given latitudes from each other; and in the tables ſeek the rhumb, under which the diſtance run anſwers to the given difference of latitude. Subſtract the longitude under the rhumb, anſwering the latitude of the place ſailed to, and that under the ſame rhumb againſt the latitude of the term ſailed to, from each other; the remainder is the difference of longitude ſought.

The operation in *plain ſailing*, runs thus.—A rhumb is to be found from the difference of latitude, and the diſtance; and from the ſame data, the departure muſt be found, likewiſe; which may be alſo determined from the rhumb now found, and the difference of latitude; or from the rhnmb and the diſtance run. Laſtly, from the departure the difference of longitude is to be found.

VI. *The difference of longitudes of the places ſailed to and from, with the latitude of one of the places, and the diſtance run being given; to find the rhumb and the latitude of the other, in* Mercator's *ſailing*; a right line is drawn thro' the place given in the map, parallel to the meridian, making another line equal to the difference of longitude; then another parallel is drawn which will be the meridian the ſhip is arrived at. Afterwards with the interval of the diſtance run, an arch is deſcribed interſecting the meridian, whereby the place ſought is found.

By the tables. We may take a rhumb at pleaſure, and under the ſame, in the tables, find the longitude, and the diſtance anſwering to the given latitude. Adding the given diſtance to the diſtance found in the tables, if the veſſel ſailed from the equator; or ſubſtracting it therefrom, if it ſailed towards the ſame. With the ſame ſum, or the difference, we muſt enter the tables; ſubſtracting or adding the longitude found againſt it, to that juſt found. If the remainder be found the given difference of longitudes, the rhumb is well taken. Otherwiſe it muſt be changed for a more, or leſs oblique one; till the ſame operation being repeated, the

the remainder be found the difference of longitudes; then the latitude in the first column, corresponding to the distance, will be the latitude of the other place.

The operation in *plain sailing*, is made by converting the difference of longitudes into miles of longitude for the departure; seeking the rhumb from the given departure and distance run; and from the same, and the rhumb, seeking the difference of latitude; which, and the latitude of one place being had, the latitude of the other readily follows.

VII. *The difference of longitude, and the latitude of one of the places given, together with the rhumb, to find the differences run, and the latitude of the other place, by* Mercator's *sailing:* the compass must be placed on the *chart* as before; and by the given rhumb the rhumb-line is drawn, and a meridian thro' the given place, and another with the interval of the difference of longitude, for that the vessel is arrived at. Where this intersects the rhumb-line, is the place where the vessel is arrived at. Wherefore if thro' that place be drawn a line parallel to the rhumb-line, the distance between both lines will be the latitude of the place. The distance run is easily reduced into miles by the scale.

By the tables. Under the given rhumb, seek the distance run, and the difference of longitude answering to the given latitude. If the vessel has sailed towards the pole, the difference of longitude is to be added to the given difference of longitude; if towards the equator, it is to be substracted from the same. In the former case descend in the table, and in the latter, ascend; till in the first, the aggregate, in the latter, the difference be seen in the column of longitude. The latitude answering hereto in the first column, is that sought. And from the distance answering to the latitude in the first case, the tabular distance is to be substracted. What remains is the distance run.

In *plain sailing*, the difference of longitude must be reduced into miles of longitude or departure, as under the first case. From the departure and the rhumb, the distance run is found; and from these, or from the rhumb, and the distance run, the difference of latitude. This done, as the latitude of the one is already had, that of the other is so too.

RHUMB, according to *Aubin*, is a line on the terrestrial globe, sea-compass, or sea-chart, representing one of the 32 winds, which serve to conduct a vessel. So that the *rhumb* a vessel pursues, is conceived as its rout or course.

Rhumbs are divided, and subdivided like points. Thus the whole *rhumb* answers to the cardinal point. The half *rhumb* to a collateral point, or makes an angle of 45 degrees with the former. The quarter *rhumb* makes an angle of $22^{\circ}\ 30'$ therewith. And the half quarter *rhumb* makes an angle of $11^{\circ}\ 15'$

RHUMB-LINE, *loxodromia*, is the line which a ship keeping in the same collateral point or *rhumb*, describes throughout its whole course.

The great property of this *rhumb-line*, or *loxodromick*, and that from which some authors define it, is, that it cuts all the meridians under the same angle. This angle is called the *angle of the rhumb*, or the *loxodromick angle*.

The angle, which the *rhumb-line* makes with any parallel to the equator, is called the complement of the *rhumb*.

The use of the *rhumb-line* in *Navigation*, is as follows. 1. If several meridians be not very far apart, the *rhumb-line* is divided by the equi-distant parallels, into equal parts.

Hence, 1. The parts of several *rhumb-lines*, are as the several latitudes of the places the ship sails from and to. 2. Since the arches form'd thereby are equal in magnitude, and therefore unequal in numbers of degrees, the sum of the arches, called the *latus mecodinamicum*, or miles of longitude, is not equal to the difference of longitude of the two places above-mentioned.

2. The length of the *rhumb-line* is to the change or difference of latitude, in the same ratio as the whole sine to the co-sine of the angle of the *rhumb*.

Hence, 1. The *rhumb* sailed on being given, together with the difference or change of latitude, turned into miles; the length of the *rhumb-line*, or the distance from one place to another upon the same *rhumb*, is had by the Rule of Three. 2. The *rhumb-line* being given, together with the quantity of the ship's way, on the same *rhumb*; the difference of latitude is had by the Rule of Three, in miles to be converted into degrees of a great circle. 3. The difference of latitude being given in miles; as also the length of the *rhumb-line*; the angle of the *rhumb*, and consequently the *rhumb* sailed on, is had by the Rule of Three. 4. Since the co-sine is to the whole sine, as the whole sine to the secant; the difference of latitude is to the length of the *rhumb-line*, as the whole sine to the secant of the *rhumb*.

3. The length of the *rhumb-line*, or of the ship's way in the same *rhumb*, is to the *latus mecodinamicum*, or *mecodinamick side*, as the whole sine to the sine of the *loxodromick angle*.

Hence, 1. The *rhumb*, or angle of the *rhumb*, being given, as also the ship's way in the same *rhumb-line*; the *mecodinamick* side is had by the Rule of Three, in miles, *i. e.* in the same measure wherein the length of the *rhumb* is given. 2. In like

like manner, the *mecodinamick* ſide being given, as alſo the *rhumb-line* or ſhip's way; the *rhumb* ſailed in, is found by the Rule of Three.

4. The change of latitude, is to the *mecodinamick* ſide, as the whole ſine to the tangent of the *loxodromick angle*.

Hence the *rhumb* or *loxodromick angle*, and the change of latitude being given; the *mecodinamick* ſide is found by the Rule of Three.

5. The *mecodinamick* ſide is a mean proportional, between the aggregate of the *rhumb*, and the change of latitude, and their difference.

Hence the change of latitude, and the *rhumb-line*, being given in miles; the *mecodinamick* ſide is found in the ſame meaſure.

6. The *mecodinamick* ſide being given, to find the longitude.

Multiply the change or difference of latitude by ſix, which reduces it into parts, of ten minutes each; divide by the product the *mecodinamick* ſide; the quotient gives the miles of longitude, anſwering to the difference of latitude in ten minutes; reduce theſe miles of longitude in each parallel into differences of longitude, from a *loxodromick* table: the ſum of theſe is the longitude required.

7. If a ſhip ſails on a north or ſouth *rhumb*, it deſcribes either the equinoctial, or a parallel thereto.

8. To find the *rhumb* between two places, by *calculation*, or *geometrically*, we have two canons or proportions: the firſt, as the radius is to the half ſum of the co-ſines of both latitudes; or (rather for geometrical ſchemes) as the diameter is to the ſum of the co-ſines of both latitudes, ſo is the difference of longitude, to the departure from the meridian.

For an example of the former proportion.—Let the *rhumb* be required between Cape *Finiſter*, lat. 43° long. 7°, 20′, and St. *Nicholas* iſle, lat. 38°, long. 352°. The middle latitude is 40°, 30′, the complement 49°, 30′, and the difference of longitude 15°, 20′; out of theſe leſſer equal parts, prick down 15°, and deſcribe an arch with 60° of the chords, and make it equal to 49°; then draw an arch continued to the further diſtance, making the neareſt diſtance the leg of a right angled triangle, and the other leg the difference of latitude 5°, which muſt be pricked from the equal parts. Thus the extent meaſured on the ſaid parts, ſhews the diſtance to be 13°, 24′; which allowing 20 leagues to a degree, is almoſt 268 leagues. Then the *rhumb* triangle muſt be croſſed with the radius; which extent meaſured on the greater chord is almoſt 22°, the complement whereof is 68°; and ſo much is the *rhumb* from the meridian between the two places, amounting to 6 points, and upwards of 80 minutes.

For an inſtance of the laſt proportion.—Let it be required to find the *rhumb* and diſtance between the *Lizard* and *Bermudas*, the latitude of the *Lizard* being 56°, and that of *Bermudas* 32°, 20′; or 32°, 4′, centeſms, and their difference of longitude, 55°, two lines muſt be drawn at right angles, and with 60° of the leſſer chords, a quadrant muſt be deſcribed, and radius pricked, the ſecond line drawn will be the diameter; then counting both latitudes, the neareſt diſtance is the co-ſine of *Bermudas* latitude; and the neareſt diſtance to this is the co-ſine of the *Lizard*'s latitude. Then drawing again another line, and pricking down 55 degrees out of the greateſt equal parts, and a parallel to the line laſt drawn, the diſtance from the firſt of the 55 degrees to the right end of the parallel is the departure from the meridian in the courſe between both places. Making that, therefore, one leg of a right angled triangle, prick down 17°, 59 centeſms, the difference of latitude between thoſe places, and at the ſame equal parts draw a line. This repreſents the courſe and diſtance between the *Lizard* and *Bermudas*; and the extent meaſured on the ſame equal parts, ſhews the diſtance to be 44°, 31 centeſms, which allowing 20 leagues to a degree, is 886 leagues.

The next inſtrument is the *azimuth compaſs*, which differs from the *common compaſs* in this, that there is faſtened on the round box wherein the card is, a broad circle, one half whereof is divided into 90 degrees; and thoſe ſubdivided diagonally into minutes. The index has a ſight moving on a hinge. From the upper part of the ſight, to the middle of the index, is faſtened a fine hypothenuſal luteſtring, to give a ſhadow on a line in the middle of the index. The circle is croſſed at right angles with two threads, from the extremities whereof are drawn four lines on the inſide of the round box: there are alſo four lines drawn at right angles to each other on the card. The round box fitted with its card, graduated circle, and index, is hung in braſs hoops, and thoſe hoops faſtened to a ſquare box.

The uſe of the AZIMUTH COMPASS, is for finding the ſcale, magnetical azimuth, or amplitude; and thence the variation of the compaſs.

If the obſervation be for an amplitude at ſunriſing, or an *azimuth* before noon; apply the center of the index on the weſt point of the card, within the box; ſo that the four lines on the edge of the card, and thoſe on the inſide of the box may meet. If the obſervation be for the ſun's amplitude ſetting, or an *azimuth* in the afternoon, turn the center of the index right againſt the eaſt point of the card, and make the lines within the box concur with thoſe on the card: the inſtrument

thus fitted for obſervation, turn the index towards the ſun, till the ſhadow of the thread falls directly on the ſlit of the ſight, and on the line that is along the middle of the index; then will the inner edge of the index cut the degree and minute of the ſun's magnetical *azimuth* from the north or ſouth.

But note, that if, when the compaſs is thus placed, the *azimuth* is leſs than 45 degrees from the ſouth, and the index turned towards the ſun, it will paſs off the diviſions of the limb: the inſtrument, therefore, in this caſe, muſt be turned juſt a quarter of the compaſs, *i. e.* the center of the index muſt be placed on the north or ſouth point of the card, according as the ſun is from you; and then the edge will cut the degree of the magnetick *azimuth*, or ſun's *azimuth* from the north as before.

The ſun's magnetical amplitude thus found, the variation of the needle is thus determined.

Being out at ſea the 15th of *May*, 1759, in 45° north latitude, the tables give you the ſun's latitude 19° north, and its eaſt amplitute 27° 25′ north: by the *azimuth compaſs*, we find the ſun's magnetical amplitude, at its riſing and ſetting; and finds he riſes, *v. gr.* between the 62d and 63d degree, reckoning from the north towards the eaſt point of the compaſs, *i. e.* between the 27th and 28th deg. reckoning from the eaſt.

The Equinoctial Compass, which we have, likewiſe, among our inſtruments, ſerves to know at what point is the moon. That compaſs being riſen on the ſuperficies of the equinoctial line, divides it juſtly into equal parts, as the common compaſs does the horizon. We ſee the line which runs through the figure of that compaſs, repreſents the axis of the world. The round before the compaſs muſt be marked on both ſides, as well upwards and downwards, inſide with a common compaſs, and on the outſide with twice twelve hours: and on both ſides, which mark the eaſt and weſt, it muſt be ſuſpended on the tops of two pegs, as an axle-tree, ſo that it may turn upwards, and that the lower part of the arrow, which is on the quadrant, may be placed on all the altitudes of the pole.

The Nocturnal Compass, is a very common inſtrument, uſed to find at all hours of the night, how much the *northern ſtar* is higher or lower than the pole. It is alſo called a *quadrant for the ſtars*, becauſe it ſhews the hours in the night by means of the ſtars. Mariners make uſe moſt commonly for that purpoſe, of the ſtars of *Urſa major*, in this hemiſphere, becauſe they are more remarkable than the others which are nearer the northern pole; but in the other hemiſphere, or beyond the line, they chuſe the *Cruſade*, which is a conſtellation compoſed of four ſtars, which are eaſily diſtinguiſhed.

As the Sector, or *compaſs of proportion*, is a mathematical inſtrument, of great uſe in finding the proportion between quantities of the ſame kind, as between lines and lines, ſurfaces and ſurfaces, *&c.*

The great advantage of the *ſector* above the common ſcales, *&c.* is, that it is made ſo as to fit all radius's and ſcales. By the lines of chords, ſines, *&c.* on the *ſector*, we have lines of chords, ſines, *&c.* to any radius betwixt the length and breadth of the *ſector* when opened.

The *ſector* is founded on the fourth propoſition of the ſixth book of *Euclid*, where it is demonſtrated, that ſimilar triangles have their homologous ſides proportional.

This inſtrument conſiſts of two equal rules, or legs of braſs, or other matter, riveted together; but ſo as to move eaſy on the rivet. In the faces of the inſtrument are placed ſeveral lines: the principal are the line of equal parts, line of chords, line of ſines, line of tangents, line of ſecants, and line of polygons.

The *line of equal parts*, called alſo *lines of lines*, marked 6, is a line divided into 100 equal parts; and where the length of the line will allow it, each is ſubdivided into halves and quarters. It is founded on each leg, on the ſame ſide; and the diviſions numbered 1, 2, 3, 4, *&c.* to 10, which is near the extremity of each line. In practice 1 is taken for 10, or 100, or 1000, or 10,000, *&c.* as occaſion requires; in which caſes 2 repreſents 20, or 200, or 2000, *&c.* and ſo of the reſt.

The *line of chords*, marked C on each leg, is divided after the uſual manner, and numbered 10, 20, 30, *&c.* to 60.

The *line of lines*, denoted on each leg by the letter S, is a line of natural ſines, numbered 10, 20, 30, *&c.* to 90.

The *line of tangents*, denoted on each leg by the letter T, is a line of natural *tangents*, numbered 10, 20, 30, *&c.* to 45; beſides which is another little line of *tangents* on each leg, commencing at 45, and extending to 75°; denoted by the letter T.

The *line of ſecants*, denoted on each leg by the letter S, is a line of natural ſecants, numbered 10, 20, 30, *&c.* to 75, and commencing, not from the center of the inſtrument, but at two inches diſtance therefrom.

The *line of polygons*, denoted by the letter P, on each leg is numbered 4, 5, 6, *&c.* to 12, which falls 12 inches ſhort of the center of the inſtrument.

Beſides theſe lines, which are eſſential to the *ſector*, there are others placed near the outward edges

edges on both faces, and parallel, which are in all reſpects the ſame as in *Gunter*'s ſcale, and uſed after the ſame manner. Such are the lines of artificial ſines, marked S; the line of artificial tangents, a line of 12 inches, marked M, and *Gunter*'s line of numbers marked N. There are ſometimes other lines placed to fill up the vacant ſpaces, as the lines of hours, latitudes, and inclinations of meridians, which are uſed the ſame as on the common ſcales.

JACOB-STAFF, the ſame with *croſs-ſtaff*, is a mathematical inſtrument for taking heights and diſtances.

The *jacob*, *croſs*, or *fore-ſtaff*, takes its denomination hence, that the obſerver in uſing it, turns his face towards the object; in contradiction to *back-ſtaff*, where he turns his back to the object. The *fore* or *croſs-ſtaff*, repreſented in our table of the magnet, conſiſts of a ſtraight, ſquare, graduated ſtaff, and four croſſes or vanes, which ſlide thereon. The firſt, or ſhorteſt of theſe vanes, is called the *ten croſs*, or *vane*, and belongs to that ſide of the inſtrument, whereon the diviſions begin at 3 degrees, and end at 10. The next longer vane is called the *thirty-croſs*, belonging to that ſide of the ſtaff, wherein the diviſions begin at 10 degrees, and end at 30, called the *thirty ſcale*. The next vane is called the *ſixty-croſs*, and belongs to the ſide where the diviſions begin at 20 degrees, and end at 60. The laſt, and longeſt, called the *ninety-croſs*, belongs to the ſide whereon the diviſions begin at 30 degrees, and end at 90.

The great uſe of this inſtrument is to take the height of the ſun and ſtars, or the diſtance of two ſtars; and the ten, thirty, ſixty, or ninety croſſes, are to be uſed according as the altitude is greater or leſſer, that is, if the altitude be leſs than 10 degrees, the tenth croſs is to be uſed; if above ten, but leſſer than thirty, the thirtieth croſs to be uſed, *&c.*

To obſerve an altitude by the *fore-ſtaff*, apply the flat end of the ſtaff to your eye, and look at the upper end of the croſs of the center of the ſun or ſtar, and at the lower end for the horizon. If you ſee the ſky inſtead of the horizon, ſlide the croſs a little nearer the eye; and if you ſee the ſea inſtead of the horizon, ſlide the croſs further from the eye: and thus continue moving, till you ſee exactly the ſun or ſtar's center, by the top of the croſs, and the horizon by the bottom thereof.

Then the degrees and minutes cut by the inner edge of the croſs upon the ſide of the *ſtaff*, peculiar to the croſs you uſe, is the altitude of the ſun or ſtar.

If it be the meridian altitude you want, continue your obſervation as long as you find the altitude increaſe, ſtill moving the croſs nearer to the eye.

By ſubtracting the meridian altitude thus found, from 90 degrees you will have the zenith diſtance.

To work accurately, an allowance muſt be made for the height of the eye, above the ſurface of the ſea, *viz.* for 1 *Engliſh* foot, 1 minute, for 5 feet $2\frac{1}{2}$, for 10 feet $3\frac{1}{2}$, for 20 feet 5, for 40 feet 7, *&c.*

Theſe minutes ſubtracted from the altitude obſerved, and added to the zenith diſtance obſerved, give the true altitude, and zenith diſtance.

To obſerve the diſtance of two ſtars, or the moon's diſtance from a ſtar, by the *fore-ſtaff*. Apply the inſtrument to the eye, and looking to both ends of the croſs move it nearer, or farther from the eye, till you ſee the two ſtars; the one on one end, and the other on the other end of the croſs; then the degrees and minutes cut by the croſs on the ſide proper to the vane in uſe give the ſtar's diſtance.

The *back-ſtaff*, conſiſts of three vanes, and of two arches, *viz.* the *horizon vane*, the *ſhade vane*, and the *ſight vane*.

To uſe this *ſtaff*, the *ſhadow vane* is ſet upon the arch, to an even degree of ſome altitude, leſs by 10, or 15 degrees than you judge the complement of the ſun's altitude will be; and the *ſight vane* on the thirtieth arch: the obſerver's back being then turned to the ſun, (whence the name of *back-ſtaff*, or *back-quadrant*) he lifts up the inſtrument, and looks through the *ſight vane*, raiſing or falling the quadrant, till the ſhadow of the upper edge of the *ſhade-vane*, fall on the upper edge of the ſlit in the *horizon-vane*; and then if you can ſee the horizon through the ſaid ſlit, the obſervation is well made; but if the ſea appears inſtead of the horizon, move the *ſight-vane*: if the ſky appears move it upwards. and ſo try if it comes right; then obſerve how many degrees and minutes are cut by that edge of the *ſight-vane*, which anſwers to the ſight hole, and to them add the degrees cut by the upper edge of the *ſhade-vane*; the ſum is the ſun's diſtance from the zenith, or the complement of his altitude.

To find the ſun's meridian, or greateſt altitude on any day, continue the obſervation as long as the altitude is found to increaſe, which you will perceive by the appearance of the ſea inſtead of the horizon, removing the *ſight-vane* lower; but when you perceive the ſky appear inſtead of the horizon, the altitude is diminiſhed: therefore deſiſt from further obſervation at that time, and add the degrees upon the ſixtieth arch to the degrees and minutes upon the thirtieth arch, and the ſum is the zenith diſtance, or co-altitude of the ſun's upper limb.

And becauſe it is the zenith's diſtance, or co-al-

titude of the upper limb of the ſun, not the center that is given by the quadrant, in obſerving by the upper end of the *ſhade-vane*, add 16 minutes, the ſun's ſemi-diameter, to that which is produced by your obſervation, and the ſum is the true zenith diſtance of the ſun's center. If you obſerve by the lower part of the ſhadow of the *ſhade-vane*, then the lower limb of the ſun gives the ſhadow; and therefore you muſt ſubſtract 16 minutes from what the inſtrument gives; but conſidering the height of the obſerver above the ſurface of the ſea, which is commonly between 16 and 20 feet, you may take 5 or 6 minutes from the 16 minutes, and make the allowance but of 10 or 12 minutes to be added inſtead of 16 minutes.

M. *Flamſtead* contrived a glaſs lens, or double convex, to be placed in the middle of the *ſhade-vane*, which makes a ſmall bright ſpot on the ſlit of the *horizon-vane*, inſtead of the ſhade; which is a great improvement, if the glaſs be truly made: for by this means the inſtrument may be uſed in hazy weather, and a much more accurate obſervation made in clear weather, than could be by the ſhadow.

From this I'll paſs to examine the *log-line*, which is a little cord or line faſtened to one end of the *log*, and wound round a reel, fixed for that purpoſe in the gallery of the ſhip.

A *log* is a ſmall piece of wood of a triangular figure on board a ſhip; into one end whereof a convenient quantity of lead is caſt, to make it ſwim upright in the water; the other end being faſtened to a line.

This line from the diſtance of about ten fathom off the log, has certain knots or diviſions, which ought to be at leaſt 50 feet from each other; though it is the common practice at ſea not to have them above 42 feet aſunder.

The uſe of the *log* and *line*, is to keep account, and make an eſtimate of the ſhip's way, or diſtance run, which is done by obſerving the length of the line unwound in half a minute's time, told by a half-minute glaſs; for ſo many knots as run out in that time, ſo many miles the ſhip ſails in an hour.

Thus, if there be four knots veered out in half a minute, the ſhip is computed to run four miles an hour.

To heave the log, as they call it, they throw it into the water, letting it run till it comes without the eddy of the ſhip's waſte, then one holding a half-minute glaſs, turns it up juſt as the firſt knot turns off the reel (though ſome turn the glaſs as ſoon as the log touches the water) as ſoon as the glaſs is out the reel is ſtopped, and the knots run off are told, and their parts eſtimated.

The log ought to be heaved every hour, or every two hours.

There is alſo the *log-board*, which is a table divided into four or five columns, whereon are marked the reckoning of every day; from whence they are entered into the *log-book*, or traverſe-book, ruled and columned juſt as the log-board is: whence it may be tranſcribed into the journals, and how much the ſhip gains in her courſe be eſtimated daily.

In the firſt column of the log-board is entered the hour of the day, from one to one: in the ſecond, the rhumb, or the direction of the veſſel, with regard to the points of the compaſs: in the third, the number of knots run off the reel each time of heaving the log: in the fourth, the wind that blows; and in the fifth, obſervations made of the weather, variation of the compaſs, *&c.*

A *Journal* is a regiſter kept by the pilot, wherein notice is taken of every thing that happens to the ſhip from day to day, and from hour to hour, with regard to the wind, the rhumbs, the rake, ſoundings, *&c.* in order to enable him to adjuſt the reckoning, and determine the place where the ſhip is: thus,

JOURNAL *of* 12 *hours.*

Rhumb.	*Value of the Rhumb.*	*Wind.*	*Quality of the Wind.*	*Leagues of* 3000 *Paces.*
W. N. W.	W. N. W	E. S. E. back	middling	2
W. N. W.	W. N. W	E. S. E. back	good or freſh.	3
W. N. W.	W. N. W.	E. S. E. back	middling.	2
W. N¼ W.	W. N. W.	S. E. ſidewiſe.	good	4
W. N½ W.	W. N. W.	S. E. ſidewiſe	middling	1½
N. W.	W. N. W.	S. E. ſidewiſe	little Wind	2
N. W.	W. N. W.	S. E. ſidewiſe	middling	1½
N. N. W.	N. W.	E. S. E Quarter.	good	8

From

From the Firſt Day of March *at Noon.*

Hour Glaſſes of half Hours.	Latit. valued. D.	M.	Lat. obſerv'd. D.	M.	Longitude. D.	M.	Declenſion of the Needle. D.	M.
2			41.		5.		2. *Eaſt*	30.
2								
2								
4								
2								
4								
2								
6	41.	50.	41.	30.	3.	15.	1.	10.

12 *at Night.*

Journal, 1759.

In this journal we ſuppoſe to have conveyed ſome merchant-ſhips to *Liſbon*, whence we proceed on our voyage to *Jamaica*.

In the Name of God, *Amen*.

The 27th of *February*, at noon, the wind being north-north-eaſt, we ſailed from the gulph of *Liſbon*, to proceed, with God's aſſiſtance, on our voyage to *Jamaica*, in his Majeſty's ſhip the *N.* 400 tons burthen, carrying 36 guns; the captain *M. P.* the lieutenant *M. R.* and the firſt pilot *N.* God grant us a good voyage.

We anchored by about 12 fathoms of water, and after we had waited till the 18th, we heaved up our anchor at ſix in the morning, with a middling eaſterly wind; and after we had doubled the cape of *Rocca*, we put the cape to the north-weſt till ſix in the evening; but that rhumb was worth but weſt-north-weſt to us, becauſe of the currents, and we reckoned to have made 25 leagues.

About ſix in the evening, the wind being turned to the ſouth, we kept ſtill the cape to the north-weſt, therefore that ſame wind having laſted till twelve at noon the next day, we reckon'd to have ſailed 55 leagues by that rhumb. For having made our obſervation, we found ourſelves at 40 degrees of latitude, and by eſtimate at 5 of longitude.

Rhumb.	*Value of the Rhumb.*	*Wind.*
N. W.	W. N. W.	E. *Mid.*
N. W.	N. W.	S. *Good.*

Leagues.	*Latitude.*	*Longitude.*
25	38 Deg. 30 Min.	9 Deg. 15 Min.
55	41 Deg. 0 Min.	5 Deg. 0 Min.

From twelve at noon, of the 1ſt day of *March*, we ſailed on the north-weſt, ¼ weſt, with a very unſettled wind, ſometimes good, ſometimes middling, which blew part from the eaſt-ſouth-eaſt, and part from the ſouth-eaſt. We reckoned to have ſailed 24 leagues in 12 hours and to be under the 41°, 50′, of latitude. And by that obſervation, judged that we were under the 3° 15′ of longitude, and that ſame current had made us lie by weſt-north-weſt.

The ſecond day of the ſame month, we were overtaken by a violent tempeſt, mixed with thunder and lightning, and night happening all on a ſudden, a prodigious *puchot* (which is a kind of whirlwind) ſeized our ſhip by the bowſprit with ſo much violence, that it laid her on her ſide; we then thought ourſelves loſt; but that whirlwind finding no hold on that ſide of the ſhip, was ſoon over, and our ſhip raiſed herſelf by degrees. We were forced to throw ſome pieces of cannon, and ſome merchandizes over-board; becauſe the tempeſt continued till the next day, and was followed by very foul weather, which continued till the 5th in the morning; and that day having made an obſervation at noon, we found ourſelves under the 39° 12′; and having told our hour-glaſſes, for 12 at noon of the firſt day of *March*, there were but 193, *i. e.* one more than four times 48, wanted for the four days, at that time there could be one quarter of the ſand run through. We reckoned then, that we could be diſtant from the meridian of the place, where we were the firſt of *March*, at noon, but of about 9 degrees weſtward; becauſe the ſun running thro' 7½ in a half hour, the degree and a half above was reckoned for the quarter of the ſand run at the time of the obſervation; and that, therefore, we could be under the 356 degrees of longitude.

By that reaſoning we corrected our eſtimate, and judge, in pointing our chart, that we had made 115 leagues, and that we were diſtant from the *Tercera* iſlands, of about 40 leagues.

Rhumb.	*Value of the Rhumb.*	*Wind.*
N. W. ¼ W.	W. N. W.	E. S. E. *middling.*
W. N. W.	W. S. W.	N. N. E. *Tempeſt.*

Leagues.	*Latitude.*	*Longitude.*
24	41° 30′	3° 15′
115	39° 12′	356° 0′

6. We were ſcarce recovered from our fright, cauſed by the tempeſt, then the 6th of *March* about eight

eight in the morning, we diſcovered four *Spaniſh* men of war, which chaſed us; but as we were not capable to cope with them, we ſet out all our ſails, and putting the cap to the north, we bore away for the iſle of *St. Michael*, where we caſt anchor about five in the evening under ſhelter of the caſtle, which we ſaluted with two pieces of cannon, and though it be not a very ſafe place, the enemy did not dare to attack us there.

Rhumb.	*Val. of the Rhumb.*	*Wind.*
S. S. W.	S. S. W.	N. good.
Leagues.	*Latitude.*	*Longitude.*
22	38° 15′	355° 20′

7. The weather was fair enough during the five days we were forced to remain in the road of that iſland, to refit our ſhip by the governor's leave, who gave us freſh proviſions. We took our obſervation, and found that our compaſs declined no longer.

12. The twelfth, at ten in the morning we hove up our anchor by a good wind of ſouth-eaſt, and ſailed towards the iſland *Tercera*, which we ſaluted with two pieces of cannon. The next day early in the morning we continued our voyage towards *Jamaica*.

This is the plan and order which can be followed in a grand journal: ſome reduce it into a table of ten or twelve columns, like that of 24 hours, but make the ſquares four times bigger, to have more room for their particular obſervations.

OPTICKS.

OPTICKS, according to Sir *Iſaac Newton*, is a mixed mathematical ſcience, which explains the manner wherein viſion is performed in the eye; treats of ſight in the general; gives the reaſon of the ſeveral modifications or alterations which the rays of light undergoes in the eye; and ſhews why objects appear ſometimes greater, ſometimes ſmaller, ſometimes more diſtinct, ſometimes more confuſed, ſometimes nearer, and ſometimes more remote.

I'll begin this by treating of ſight in general; and previouſly to it, by an exact deſcription of ſeveral parts which compoſe the eye; then I'll paſs to *catoptricks*, and from thence to *dioptricks*, leaving *perſpective* for a treatiſe a-part.

The organ of *ſight* is the eye; the author of nature has provided for the ſecurity of both eyes, by placing them under the forehead, on the ſides of the noſe, in two orbits, dug in the bones of the cranium, that in thoſe oſceous ſeats, they may be the better ſhelter'd againſt all foreign accidents. To theſe orbits, he was pleaſed to add, for a ſtill greater ſecurity, two eye-lids, or veils, to cover the eye, and defend it from duſt, ſmoak, and all other things which could hurt it.

There occurs in the eye lids ſeveral ſmall glands, which with the humour contained therein, water the eye; but more particularly in the great angle, called *canthus*, there is the lachrymal gland, whence tears flow.

As to the particular ſtructure of the eye itſelf; it is compoſed of three proper membranes, and of ſo many humours.

The firſt *proper membrane*, is ſaid to be expanded round the ball of the eye; the hind-part thereof, A F, is called *ſclerotica*, or hard; and the anterior, *viz.* A B, *cornea*, becauſe tranſparent like horn. *Fig.* 6.

The ſecond, which is thinner, proceeds from the *pia mater*, and is commonly called in its poſterior parts C C *choroides*, and *uvea* in its anterior, Q II Q.

The perforation of the *uvea*, II. is called the *pupil*, or *apple* of the eye; which by means of muſcular fibres, is ſometimes contracted, when too much light offends the eye; and ſometimes dilated, when there is but a moderate light. Thoſe muſcular fibres being diſpoſed round the pupil, in a circular manner, are called the *iris*.

The third membrane, or tunick S S S, is the *retina*, ſo called as reſembling a net, and covering only the fund or bottom of the eye, oppoſite to the ſight. This membrane derives from the medullary ſubſtance, T S S S, of the *optick* nerve; and is conſidered as the proper organ of the ſight.

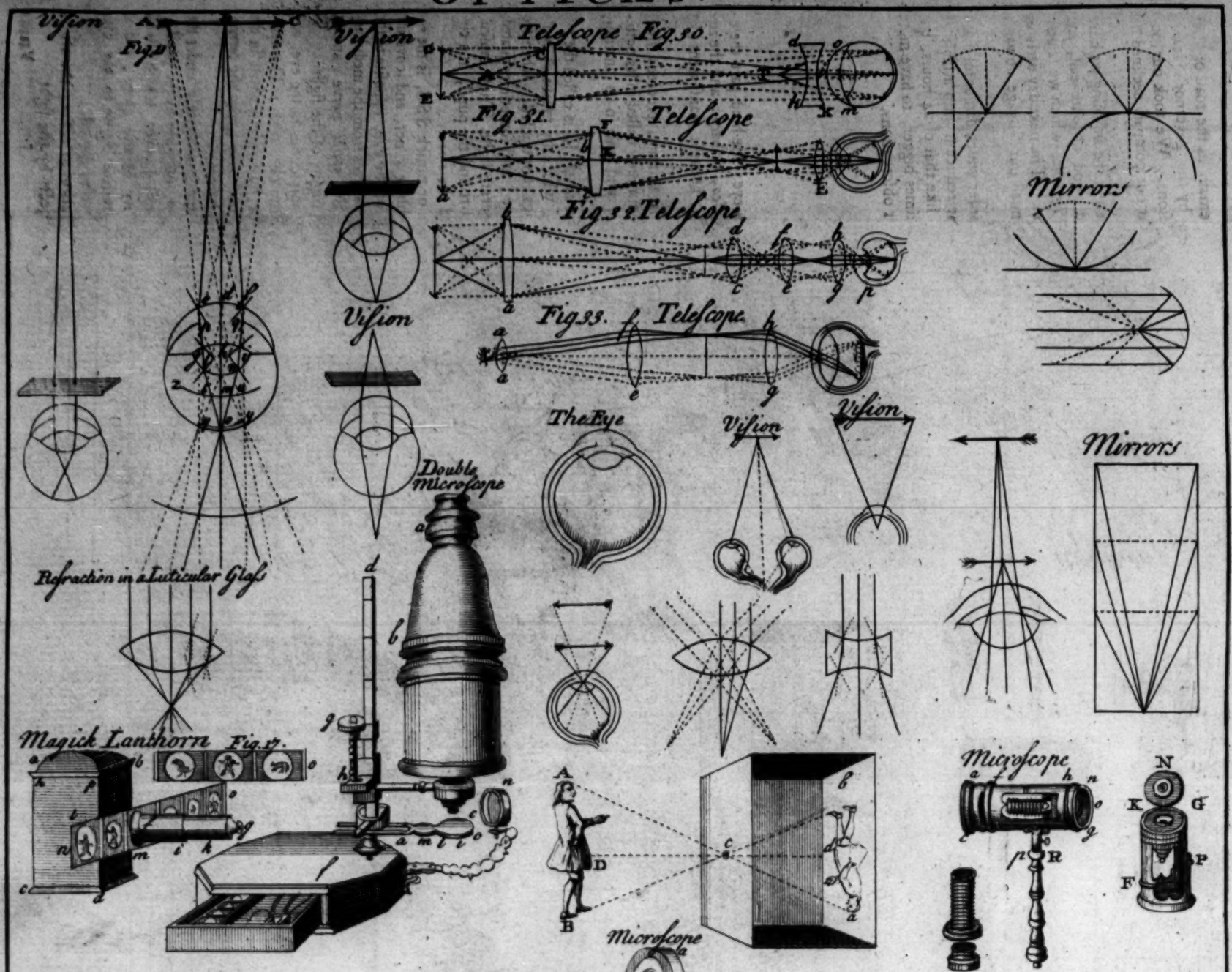
Three *humours* are conſpicuous in the eye, and incloſed between theſe tunicks, *viz.* 1 The *aqueous*, a limpid tranſparent humour, ſituated in the fore part of the eye, immediately under the *cornea*, and occaſioning its protuberance.

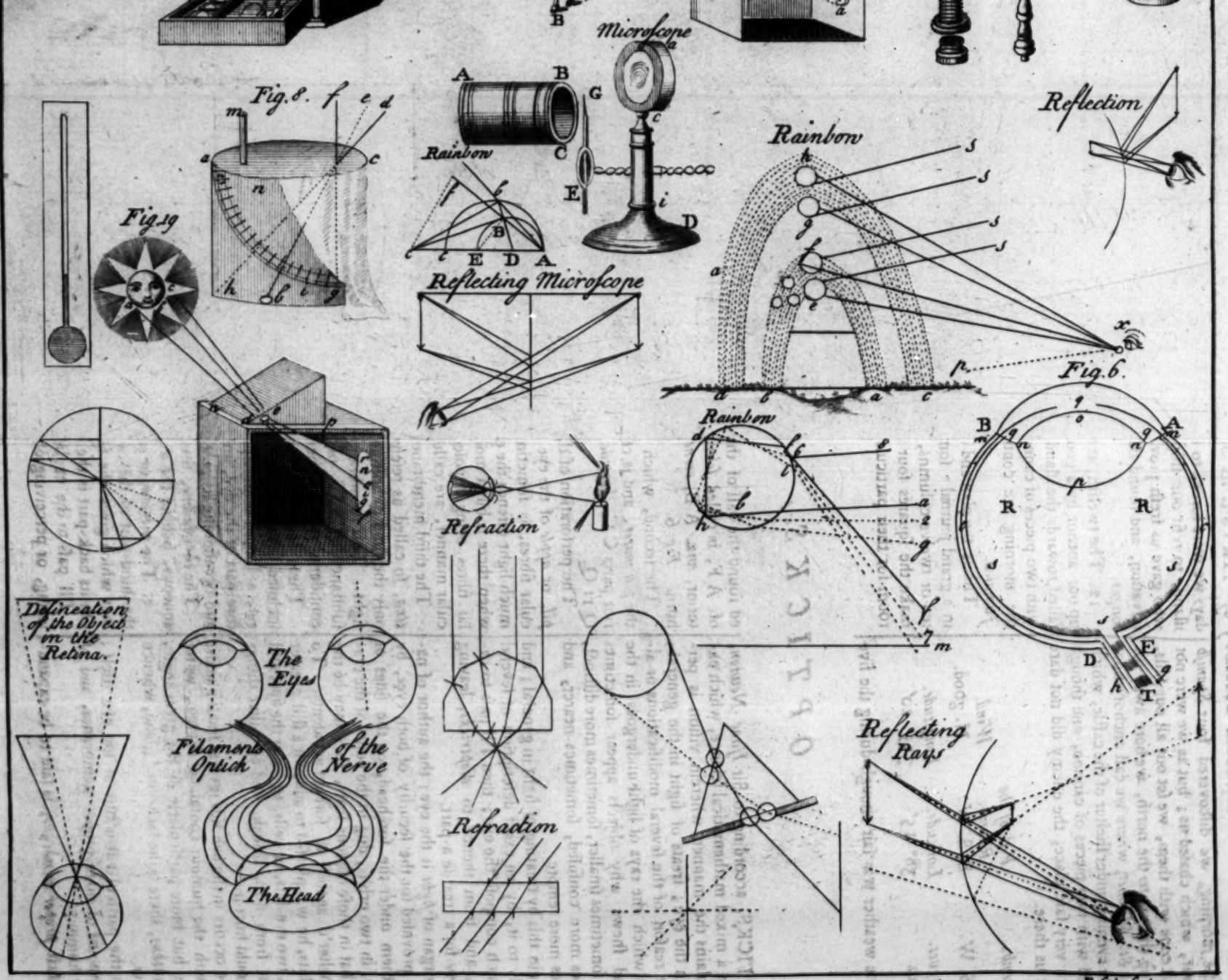
The *chryſtalline*, ſituated immediately under the aqueous, behind the *uvea*, oppoſite to the pupil.

3. The *vitreous* or *glaſſy humour*, which fills all the hind-part of the cavity of the globe; and is that which gives the ſpherical figure to the eye. On its back-part is the *retina* ſpread.

I'll paſs to the explication of *viſion*; the act of ſeeing, or perceiving objects by the ſight.

VISION


Vision
Fig. 29
Vision
Telescope Fig. 30.
Fig. 31. Telescope
Fig. 32. Telescope
Fig. 33. Telescope
Mirrors
Vision
Double Microscope
The Eye
Vision
Vision
Mirrors
Refraction in a Lenticular Glass
Magick Lanthorn Fig. 27.
Microscope
Microscope


Microscope
Fig. 8.
Rainbow
Reflection
Fig. 19
Reflecting Microscope
Rainbow
Fig. 6.
Refraction
Rainbow
Refraction
Delineation of the Object on the Retina.
The Eyes
Filaments Optick
of the Nerve
The Head
Refraction
Reflecting Rays

VISION is very well defined to be a ſenſation, whereby, from a certain motion of the *optick* nerve, made in the bottom of the eye, by the rays of light emitted or reflected from objects, and hence conveyed to the common ſenſory in the brain, the mind perceives the luminous object; its quality, quantity, figure, *&c.*

The better to underſtand this article, we muſt carefully examine the nature of *light* and *colours*, which is the medium, or vehicle, whereby objects are carried to the eye.

LIGHT is that ſenſation occaſioned in the mind, by the view of luminous bodies; or that property in bodies, whereby they are fitted to excite thoſe ſenſations in us.

Light is alſo uſed to denote a certain action of the luminous body, on a medium between it and the eye; by means whereof, ſome ſuppoſe the one to act on the other.

This they call *ſecundary* or *derivative light*; to diſtinguiſh it from that of luminous bodies, which is called *primary* or *minute*.

Every ray of light has two oppoſite ſides, the one originally endued with a property, whereon its unuſual *refraction* depends, and the other not endued with that property.

Sir *Iſaac Newton* having obſerved the vivid coloured image, projected on the wall of a darkned room, by the ſun-beams tranſmitted through a priſm, to be five times as long as broad, concludes, that *light* itſelf is a heterogeneous mixture of rays differently refrangible; and hence he diſtinguiſhes *light* into two kinds, *viz.* that whoſe rays are equally refrangible, which he calls *homogeneal*, *ſimilar*, or *uniform light*; and that whoſe rays are unequally refrangible; which he calls *heterogeneal light*.

There are but three affections of *light*, wherein he obſerved its rays to differ, viz. *refrangibility*, *reflexibility*, and colour; and thoſe rays which agree in *refrangibility*, agree alſo in the other two: whence they may be well defined homogeneal, though in ſome other reſpects they may poſſibly be heterogeneal.

Again, the colours exhibited by homogeneal *light*, he calls homogeneal colours; and thoſe produced by *heterogeneal light*, *heterogeneal colours*. Theſe definitions laid down, he advances ſeveral propoſitions.

As, firſt, that the ſun's light conſiſts of rays differing by indefinite degrees of refrangibility. Secondly, that rays which differ in refrangibility, when parted from one another, do proportionably differ in the colours which they exhibit. Thirdly, that there are as many ſimple and homogeneal colours as degrees of refrangibility; for to every degree of refrangibility belongs a different colour. Fourthly, whiteneſs in all reſpects like that of the ſun's immediate *light*, and of the uſual objects of our ſenſes, cannot be compounded of ſimple colours, without an indefinite variety of them; for to ſuch a compoſition there are required rays endued with all the indefinite degrees of refrangibility, which infer as many ſimple colours. Fifthly, the rays of *light* do not act on one another, in paſſing through the ſame medium. Sixthly, the rays of *light* do not ſuffer one alteration of their qualities from *refraction*, nor from the adjacent quieſcent medium. Seventhly, there can be no homogeneal colours produced out of *light* by *refraction*, which are not commixed in it before; ſince *refraction*, as was before obſerved, changes not the qualities of the rays, but only ſeparates thoſe which have divers qualities, by means of their different refrangibility. Eighthly, the ſun's light is an aggregate of homogeneal colours; whence homogeneal colours may be called *primitive* or *original*.

We have already obſerved, that the rays of light are compoſed of diſſimilar or heterogeneous parts; ſome of them being, in all probability greater, others leſs. Now the ſmaller the parts are, by ſo much the more refrangible they are, *i. e.* they are ſo much the more eaſily diverted out of their rectilinear courſe; and thoſe parts which differ in refrangibility (conſequently in bulk) we have alſo obſerved differ in colour.

Hence ariſes the whole theory of colours; thoſe parts, *v. gr.* which are the moſt refrangible, conſtitute violet colours (ſay ſome modern Philoſophers) that is, the moſt minute particles of light, when ſeparately impelled on the organ, do there excite the ſhorteſt vibrations in the retina, which are thence communicated by the ſolid part of the optick nerve in the brain, and excite in us the ſenſation of violet-colour, the dimmeſt and moſt languid of all colours; and thoſe particles on the contrary, which are the leaſt refrangible, conſtitute a ray of a red colour, *i. e.* the greateſt particles of *light* excite the longeſt vibrations in the retina, and ſo convey the ſenſation of a red colour, as being the moſt bright and vivid of all others. The other particles being diſtinguiſhed into little rays, according to their reſpective magnitudes and degrees of refrangibility, excite intermediate vibrations, and ſo occaſion ſenſations of the intermediate colours; in like manner as the vibrations of the air, according to their different magnitudes, excite ſenſations of different ſounds. The colours then of theſe little rays not being any adventitious modifications of them, but connate, primitive and neceſſary properties, reſulting in all probability from their different

ferent magnitudes, muſt be perpetual and immutable, not to be altered by any reflection, refraction, or any ſubſequent modification.

Others explain refraction in a clearer and more conciſe manner, and ſay that it happens either *by acceding to the perpendicular, or receding from it.* For when light paſſes from a rarer or thinner medium into one more denſe, *viz.* from air into water or glaſs, then it is refracted by acceding to the perpendicular; but when it paſſes from a thicker medium into a thinner, *viz.* from glaſs into water, or from water into air, the *refraction* happens by its receſs from the perpendicular.

But to give a ſtill clearer notion of the *refraction* of light, they illuſtrate it with the following experiments:—Therefore let us imagine that AHBGC, *Fig.* 8. is an earthen veſſel, in the bottom whereof there is the crown-piece B, that crown-piece will certainly be ſeen by the eye placed in E, by means of the ray B E; but not by the eye placed in D; for the ray D H is terminated in H, not in B. But if the veſſel be filled with water to the very top or ſuperficies, A C (which though it be ſeen here covered with a cloth, can notwithſtanding, be imagined uncovered) then the ray which was carried from the point B into E, will be refracted in the point I, where the ſuperficies of the air occurs, and tends towards D, in receding from the line F *i* G, which is perpendicular to the ſuperficies A *i* C: and then the crown-piece will be ſeen by him who will be placed in D; and will be referred not to the point B, but to the point H.

The experiment of this is eaſily made, by taking a pretty deep diſh, and putting in the bottom a crown or half a crown-piece, and then going backward from the diſh till the edges thereof hinder us from ſeeing the piece any longer; but if we put water in the diſh, we ſhall ſee the piece from that place; whence we could not ſee it before.

If the veſſel A H B G C, *Fig.* 8. be a glaſs veſſel, and the ſide C G oppoſed to the ſun, as well as the ſuperficies A *i* C, be covered in ſuch a manner, that there be but the very little hole *i* left for the paſſage of the light, then the ray D *i* will tend towards the point H. But if the veſſel be filled with water, through the ſmall tube M N, then the ray which was carried into H will be *refracted* by acceding to the perpendicular F *i* G, and environ the point B. The quantity of this *refraction* will be known, by adapting either a ſemi-circle or the quadrant of a circle within the veſſel, or in any other manner; for I do not pretend to relate here the different means invented, uſed, and adapted by the learned, to the menſuration of *refraction.*

But to underſtand better what follows; we muſt admit here the definitions of divers angles; therefore let's examine the 19th *Figure* of our table of *Opticks*, in which the ray A B is imagined to paſs obliquely from air into water or glaſs; this being directed towards P, will notwithſtanding deſcend refracted into the point I, becauſe meeting with a denſer body, by acceding to the perpendicular H B G, and for the ſame reaſon the ray K B, which inclined towards O, will incline towards L.

Then the angle A B C formed by the ray A B, and the ſuperficies B C, is called *angle of incidence*; likewiſe the angle K B C, is an *angle of incidence.*

The angle A B H, formed by the ray A B and the perpendicular H B, is the *angle of inclination*, and the ſame is to be ſaid of the angle K B M.

The angle G B I, formed by the refracted ray B I, and the perpendicular B G, is called a *refracted angle*, as well as the angle N B L.

Laſtly, the angle I B P, formed by the refracted ray B I, and the right ray A B, imagined to be carried into P (the ſame to be ſaid of the angle L B O) is called the *angle of refraction.*

Des Cartes has very ingeniouſly obſerved, that there is not always the ſame ratio between the *angles of inclination*, and thoſe *refracted.* For that ratio changes according to the various inclination of the rays; whence though the ratio which is between the angle of inclination A B H, and the refracted angle G B I, be very well underſtood, it cannot be carried to K B M and N B L, becauſe the angle A B is more inclined on the ſuperficy C B then K B. But the ratio of the ſines of the angles of inclination to the ſines of the *refracted* angles, is always the ſame, *v. gr.* if we know the ratio of the line AH, which is the ſine of the angle A B H to the line G I, which is the ſine of the refracted angle G B I; we'll find the ſame ratio between the angle K M, the ſine of the angle K B M, and the line N. L, the ſine of the angle N B L.

As to COLOUR, ſome define it a property inherent in light, whereby, according to the different ſizes, or magnitudes of its parts, it excites different vibrations in the fibres of the *optick* nerve; which propagated to the *ſenſorium*, affect the mind with different ſenſations.

Various are the opinions of antient and modern Authors, of the ſeveral ſects of Philoſophers, with regard to the nature and origin of the phænomenon *colour.*

But Sir *Iſaac Newton* thinks, that he has eſtabliſhed a ſolid and conſiſtent theory of *colours*; built on ſure experiments, and ſolving all the phænomena thereof: his doctrine is as follows:

That Author ſays, that it is found by experience, that rays, or beams of light, are compoſed of particles

ticles very heterogeneous, or diſſimilar to each other, *i. e.* ſome of them, as it is highly probable, are larger, and others leſs. For a ray of light being received on a refracting ſurface, in a dark place, is not wholly refracted to a ſingle point; but ſplit, as it were, and diffuſed into ſeveral radioli, or little rays, *i. e.* thoſe particles of the light which are the moſt minute, are of all others the moſt eaſily and moſt conſiderably diverted, by the action of the refracting ſurface, out of their rectilinear courſe: and the reſt, as each exceeds another in magnitude, ſo is it with more difficulty, and leſs conſiderably turned of its right line to the intermediate points.

Now each ray of light, as it differs from another in its degree of refrangibility, ſo does it differ from it in *colour*; this is warranted by numerous experiments. Thoſe particles, *v. gr.* which are more refracted, are found to conſtitute a ray of a violet *colour*, i. e. in all probability, the moſt minute particles of light, thus ſeparately impelled, excite the ſhorteſt vibration in the retina; which are thence propagated by the ſolid fibres of the *optick* nerves into the brain, there to excite the ſenſation of violet *colour*; as being the moſt duſky and languid of all *colours*.

Again, thoſe particles which are the leaſt refracted, conſtitute a *radiolus*, or ray of a red *colour*, i. e. the largeſt particles of light excite the longeſt vibrations in the retina; ſo as to excite the ſenſation of red *colour*, the brighteſt and moſt vivid of all others.

The other particles being in like manner ſeparated, according to their reſpective magnitudes, into little rays, excite the intermediate vibrations, and thus occaſion the ſenſation of the intermediate *colours*; much in the ſame manner as the ſeveral vibrations of the air, according to their reſpective magnitudes, excite the ſenſations of different ſounds.

To this it may be added, that not only the more diſtinct and notable colours of red, yellow, blue, *&c.* have thus their riſe from the different magnitude, and refrangibility of the rays; but alſo the intermediate degrees or ſhades of the ſame colour, as of yellow up to green, of red down to yellow, *&c.*

Further, the *colours* of theſe little rays, not being any adventitious modifications thereof, but connate, primitive, and neceſſary properties; as conſiſting, in all probability, in the magnitude of their parts, muſt be perpetual and immutable, *i. e.* cannot be changed by any future refraction or reflection, or any modification whatſoever.

In order to *viſion*, we are certain, it is required that the rays of light be thrown from the viſible object to the eye: what befalls them in the eye, will be conceived from what follows.

Suppoſe, *e. gr.* Z the eye, and A B C the object, (*Optick Plate*, Fig. 11.) now though every point of an object be a radiant point, that though there be rays reflected from every point of the object to every point of the circumambient ſpace, each carrying with it its reſpective colour, (which we falſly imagine to be thoſe of the object) yet as only thoſe rays, which paſs thro' the pupil of the eye affect the ſenſe, we ſhall here conſider none elſe.

And again, though there be a great number of rays paſſing from one radiant point, as B, through the pupil, yet we ſhall only conſider the action of a few of them; as B D, B E, B F.

Now then the ray B D falling perpendicularly on the ſurface, E D F, will paſs out of the air into the aqueous humour, without any refraction, and proceed right to H; where, falling perpendicularly on the ſurface of the cryſtalline humour, it will go on, without any refraction, to M; where again falling perpendicularly on the ſurface of the vitreous humour, it will proceed ſtrait to the point O, in the fund or bottom of the eye. Again, the ray B E paſſing obliquely out of the air upon the ſurface of the watery humour E D F, will be refracted, and approach towards the perpendicular E P: thus proceeding to the point G, in the ſurface of the cryſtalline, it will be there refracted ſtill nearer the perpendicular. — So alſo E G falling obliquely out of the air into a harder body, will be refracted towards the perpendicular G R, and falling on the point L of the ſurface of the vitreous humour, it will ſtill be brought nearer to M.

Laſtly, G L falling obliquely out of a denſer, upon the ſurface of a rarer body, L M N, will be refracted, and recede from the perpendicular L T; in receding from which, it is evident it approaches towards the ray B D O, and may be ſo refracted as to meet the other in O.—In like manner the ray B F being refracted in B will turn to I, and thence to N, and thence to the others in O. But the rays between B E and B F, being ſomewhat leſs refracted, will not meet preciſely in the ſame point O.

Thus will the radiant point B affect the fund of the eye, in the ſame manner as if the pupil had had no breadth, or as if the radiant itſelf had only emitted one ſingle ray, ſuch as were equal in power to all thoſe between B E and B F.

In like manner the rays proceeding from the point A, will be ſo refracted in paſſing through the humours of the eye, as to meet near the point X; and the rays from any intermediate point between A and B, will nearly meet in ſome other point in the fund of the eye between X and O.

Upon the whole it may be aſſerted univerſally, that every point of an object affects only one point in the fund of the eye; and, on the contrary, that

every point in the fund of the eye only receives rays from one point of the object. Though this is not to be underſtood in the utmoſt rigour.

Now if the object recede from the eye in ſuch manner, as that the radiant point B does not decline from the line B D; the rays which ſhould proceed from B, not enough divaricated, would be ſo refracted in paſſing the three ſurfaces, as that they would meet ere they reached the point O: on the contrary, if the object ſhould brought nearer the eye, the rays paſſing from the point B in the pupil, too much divaricated, would be refracted ſo as not to meet till beyond the point O; nay the object may be ſo near, that the rays proceeding from any point may be divaricated, as that they ſhall never meet at all. In all which caſes, there would be no point of the object, but would move a pretty large portion of the fund of the eye; and thus the action of each point would be confounded with that of the contiguous one.

And this would commonly be the caſe, but that nature has provided againſt it; either by contriving the eye, ſo as its bulb may be lengthened or ſhortened, as objects may be more or leſs diſtant; or, as others will have it, ſo as that the cryſtalline may be made more convex, or more flat; or, according to others, ſo as that the diſtance between the cryſtalline and the retina, may be lengthened or ſhortened.

The firſt expedient is the moſt probable; on the footing of which, when we direct our eyes to an object ſo remote, as that it cannot be diſtinctly viewed by the eye in its accuſtom'd figure, the eye is drawn back into a flatter figure, by the contraction of four muſcles; by which means, the retina becoming nearer, the cryſtalline humour receives the rays ſooner: and when we view an object too near, the eye being compreſſed by the two oblique muſcles, is render'd more globular; by which means, the retina being ſet further off from the cryſtalline, does not receive the rays of any point before they meet.

It may be here added, that this acceſs, and receſs of the cryſtalline, is ſo neceſſary to viſion, that whereas in ſome birds the coats of the eye are ſuch a bony conſiſtence, that muſcles would not have been able to contract or diſtend them; nature has taken other means, by binding the cryſtalline down to the retina, with a kind of blackiſh threads, not found in the eyes of other animals. Nor muſt it be omitted, that of the three refractions above-mentioned, the firſt is wanting in fiſhes; and that to remedy this, their cryſtalline is not lenticular, as in other animals, but globular. Laſtly, ſince the eyes of old people are generally worn flatter than thoſe of young ones; ſo that the rays from any point, fall on the retina, ere they become collected into one; they muſt exhibit the object ſomewhat confuſedly: nor can ſuch eyes ſee any but remote objects diſtinctly.

Thoſe, who have the cryſtalline of the eye thus configurated, are called *preſbytæ*. This defect is helped only by convex-glaſſes or ſpectacles; which will make the rays converge ſooner, and if they are well fitted, fall exactly on the retina. If the diſtance between the retina and the cryſtalline be too ſmall, the perſon will likewiſe be a *preſbyta*. The word is formed from the *Greek* πρεσβυς, *ſenex*; becauſe old people are naturally ſubject to this defect; time, and the friction of the eye-lids, *&c.* gradually wearing the ball flat.

In others, whoſe eyes are too globular, the caſe is juſt the reverſe; and theſe are called *myopes*.

From what has been ſhewn, that every point of an object moves only one point of the bottom of the eye; and, on the contrary, that every point in the fund of the eye, only receives rays from one point of the object; is is eaſy to conceive, that the whole object moves a certain part of the retina; that in this part there is a diſtinct and vivid collection of all the rays received in at the pupil; and that as each ray carries its proper colour along with it, there are as many points pointed in the fund of the eye, as there are points viſible in the object. Thus is there a ſpecies or picture, on the retina, exactly like the object; all the difference between them is, that the body is here repreſented by a ſurface; a ſurface frequently by a line, and a line by a point: that the image is inverted, the right hand anſwering to the left of the object, *&c.* and that it is exceedingly ſmall, and ſtill the more ſo, as the object is more remote.

What we have ſhewn of the nature of light and colours, readily accounts for this painting of the object on the retina. The matter of fact is proved by an eaſy experiment firſt tried by *Des Cartes*; thus, the windows of a chamber being ſhut, and light only admitted at one little aperture; to that aperture apply the eye of ſome animal newly killed, having firſt dextrouſly pulled off the membranes that cover the bottom of the vitreous humour, *viz.* the hind part of the ſclerotica, choroides, and even part of the retina; then will the images of all the objects, without doors, be ſeen diſtinctly painted on any white body, as on an egg-ſhell, that the eye is laid upon. The ſame thing is better ſhewn by an artificial eye, or *camera obſcura*.

The laws of *viſion*, with regard to the figures of *viſible* objects, are,

1. That if the center of the pupil be exactly againſt, or in the direction of a right line, the line will appear as one point.

2. If

2. If the line be placed in the direction of a ſurface, ſo that only one line of the perimeter can radiate on it, it will appear as a line.

3. If a body be oppoſed directly towards the eye, ſo as only one plane of the ſurface can radiate on it, it will appear as a ſurface.

4. A remote arch, viewed by an eye in the ſame place, will appear as a right-line.

5. A ſphere viewed at a diſtance appears a circle.

6. Angular figures at a diſtance appear round.

7. If the eye look obliquely on the center of a regular figure, or a circle, the true figure will not be ſeen; but the figure will appear oval.

The laws of viſion, with regard to the motion of viſibles, are, 1. That if two objects unequally diſtant from the eye, move from it with equal velocity, the more remote one will appear, the ſlower; or if their celerities be proportionable to their diſtances, they will appear to move equally ſwift.

2. If two objects, unequally diſtant from the eye, move with unequal velocities in the ſame direction, their apparent velocities are in a ratio compounded of the direct ratio's of their true velocities, and the reciprocal ones of their diſtances from the eye.

3. A *viſible* object, moving with any velocity, appears to be at reſt, if the ſpace deſcribed in the interval of one ſecond be imperceptible at the diſtance of the eye. Hence it is that a near object, moving very ſlowly, as the index of a clock, or a remote one very ſwiftly, as a planet, ſeem at reſt.

4. An object moving with any degree of velocity will appear to reſt, if the place it runs over in a ſecond of time, be to its diſtance from the eye, as 1 to 1400, nay, in fact, if it be as 1 to 1300.

5. The eye proceeding ſtrait, from one place to another, a natural object, either on the right or left, will ſeem to move the contrary way.

6. If the eye and the object move both the ſame way, only the eye much ſwifter than the object, that laſt will appear to go backwards.

7. If two or more objects move with the ſame velocity, and a third remains at reſt, the moveables will appear fixed, and the quieſcent in motion the contrary way.—Thus clouds moving very ſwiftly, their parts ſeem to preſerve their ſituation, and the moon to move the contrary way.

If the eye be moved with a greater velocity, lateral objects at reſt, appear to move the contrary way.—Thus to a perſon ſitting in a coach, and riding briſkly through a wood, the trees ſeem to retire the contrary way; and to people in a ſhip, *&c.* the ſhores ſeem to recede.

Having explained the firſt principles and rudiments of *Opticks*, with regard to the *ſpeculative* part thereof; I'll next reduce all thoſe rules into practice, and ſhew by plain demonſtration, that they are true and well founded, by means of the *catoptricks* and *dioptricks*; therefore,

CATOPTRICKS is that branch of *Opticks*, which delivers the laws of light reflected from *mirrours*.

Mirrour in *catoptricks*, denotes any poliſhed body impervious to the rays of light, and which of conſequence reflects them equally.

The doctrine of *mirrours* is founded on the following general principles. 1. Light reflected from any *mirrour* or *ſpeculum*, makes the angle of incidence equal to that of reflection. Hence a ray of light falling perpendicularly on the ſurface of a *ſpeculum*, will be reflected back upon itſelf. Which we find by experience it actually does. From the ſame point of a *mirrour*, therefore, there cannot be ſeveral rays reflected to the ſame point; ſince in that caſe, all the angles of reflection muſt be equal to the ſame angle of incidence, and therefore to each other; which is abſurd; nor can the ray be reflected to two or more points; ſince in that caſe, all the angles of reflection, would be equal to the ſame angle of incidence: which is likewiſe abſurd.

2. From every point of a *mirrour*, are reflected rays thrown on it, from every point of a radiant object. Since then rays coming from different parts of the ſame object, and ſtriking on the ſame point of the *mirrour*, cannot be reflected back to the ſame point; the rays which flow from different points of the ſame radiating object, are again ſeparated after reflection: ſo that each point ſhews whence it came. Hence it is, that the rays reflected from *mirrours* exhibit the objects to view. Hence alſo it appears, that rough uneven bodies muſt reflect the light in ſuch a manner, as that rays coming from different points will be blended or thrown confuſedly together.

Mirrours are commonly divided into *plane*, *concave*, *convex*, *cylindrical*, *conical*, *parabolical*, and *elliptical*.

Plane MIRROURS are *looking-glaſſes*.

The laws or phænomena of *plane mirrours*, are as follows. 1. Every point of an object is ſeen in the interſection of the *cathetus* of incidence, with the reflected ray.

The *cathetus of incidence*, in *catoptricks*, is a right line drawn from a radiant point, perpendicular to the reflecting line, or the plane of the *mirrour*. The *cathetus of reflection*, or of the eye, in a right line drawn from the eye, or from any point of a reflected ray, perpendicular to the plane of reflection, or of a *mirrour*.

Hence, 1. As all the reflected rays meet with the *cathetus of incidence* in the interſection; by

whatever reflected ray the radiant point be ſeen, it will ſtill appear in the ſame place. Conſequently any number of perſons viewing the ſame object in the ſame *mirrour*; will all ſee it in the ſame place behind the *mirrour*. And hence it is, that the ſame object has only one image, and that we do not ſee it double with both eyes.

Hence alſo the diſtance of the image from the eye, is compounded of the ray of incidence, and the reflected ray: and the object radiates reflectedly, in the ſame manner as it would do directly, were it removed into the place of the image.

2. The image of a radiant point, appears juſt ſo far behind a *plain mirrour*, as the radiant point is before it.

Hence, if the *mirrour*, A G, *Table Opticks*, Fig. 15. be placed horizontal, the point A will ſeem ſo much below the horizon as it is really elevated above it; conſequently erect objects will appear as if inverted; and therefore men ſtanding on their feet as if on their heads, or if their *mirrour* be faſtened to the cieling of a room, parallel to the horizon, objects on the floor will appear above the cieling as much as they really are below it; and that upſide-down.

3. In a *plain mirrour*, the images are perfectly ſimilar and equal to the objects. And hence they are us'd as looking-glaſſes.

4. In a *plain mirrour*, things on the right-hand appear as on the left, and *vice verſâ*.

Hence alſo we have a method of meaſuring any inacceſſible altitude by means of a *plain mirrour*.—Thus the *mirrour* being placed horizontally in C, *Fig.* 16. retire from it till ſuch time as the top of the tree be ſeen therein. Meaſure the height of the eye D E, the diſtance of the ſtation from the point of reflection E C, and the diſtance of the foot of the tree from the ſame. Then to E C, C B, and E D, find a fourth proportional A B. This is the altitude ſought.

5. If a *plain mirrour* be inclined to the horizon, in an angle of 45 degrees, an object perpendicular to it will appear parallel, and an horizontal object perpendicular.

6. If the object be parallel to the ſpeculum, and equally diſtant from it, with the eye; the reflecting line will be half the length of the object.

7. If *ſeveral mirrours*, or ſeveral fragments, or pieces of a *mirrour*, be all diſpoſed in the ſame plane, they will only exhibit an object once.

8. If two *plain mirrours*, or ſpecula, meet in any angle; the eye placed within that angle, will ſee the image of an object placed within the ſame. as often repeated as there may be catheti drawn, determining the places of the images, and terminated without the angle.

On this principle are founded various catoptrick machines, ſome of which repreſent objects infinitely multiplied and diſtorted; others infinitely magnified, as the *catoptrick cyſtula*, &c.

The *catoptrick cyſtula* is a machine or apparatus, whereby little bodies are repreſented extremely large, and near ones extremely wide, and diffuſed through a vaſt ſpace, with other agreeable phænomena.

To make a *catoptrick cyſtula to repreſent ſeveral ſcenes of objects, when looked in at different foramina or holes* Provide a polygonous *cyſtula*, or cheſt, of the multilateral priſm A B C D E F (plate *Opticks*, Fig. 17.) and divide its cavity by diagonal planes E B, F C, D A, interſecting each other in the center, into as many triangular locules or cells, as the cheſt has ſides. Line the diagonal planes with *plain mirrours*, in the lateral planes make round holes, through which the eye may peep within the locules of the cheſt. The holes are to be covered with plain glaſſes, ground within-ſide, but not poliſhed, to prevent the objects in the locules from appearing too diſtinctly. In each locule are placed the different objects, whoſe images are to be exhibited; then covering up the top of the cheſt with a thin tranſparent membrane, or parchment, to admit the light, the machine is compleat.

For from the laws of reflection it follows, that the images of objects, placed within the angles of *mirrours*, are multiplied, and appear ſome more remote than others; whence the objects in one locule will be ſeen, but thoſe multiplied and diffuſed through a ſpace much larger than the whole cheſt. Thus every new hole will afford a new ſcene: according to the different angles the *mirrours* make with each other, the repreſentations will be different; if they be at an angle greater than a right one, the images will be monſtrous, *&c.*

The parchment that covers the machine, may be made pellucid, by waſhing it ſeveral times in a very clear lye, then in fair water, and bracing it tight, and expoſing it to the air to dry. If it be deſired to throw any colour on the objects, it may be done by colouring the parchment. *Zahnius* recommends verdigreaſe ground in vinegar, for green; decoction of *Braſil* wood, for red, *&c.* He adds, it ought to be varniſhed to make it ſhine.

To make a *catoptrick cyſtula*, to repreſent the objects within it *prodigiouſly multiplied*, and *diffuſed through a vaſt ſpace*. Make a *polygonous cyſtula*, or cheſt, as before, but without dividing the inner cavity, into any apartments or locules. Line the lateral planes with *plane mirrours*, and at the *foramina* or apertures, pare off the tin and quickſilver, that the eye may ſee through: place any object in the bottom, *v. gr.* a bird in a cage, *&c.* Here the eye

eye looking through the apertures, will ſee each object placed at bottom, vaſtly multiplied, and the images removed at equal diſtances from one another.

Convex MIRROURS are thoſe, whoſe ſurface is convex; meaning by convex ſurfaces, ſuch as are ſpherically convex.

There are divers methods uſed by divers artiſts, for preparing or making *convex mirrours*, particularly as to the matter and compoſition. One of the beſt that is known is given us by *Wolfius*, thus: melt one part of tin, another of marcaſite together, and to the melted maſs add two parts of mercury; as ſoon as the mercury begins to evaporate into ſmoak (which it preſently does) the whole compoſt is to be thrown into cold water, and when well cooled, the water decanted off. The mixture is then to be ſtrained through a linen cloth in two or three folds; and what is thus ſcorned, poured into the cavity of a glaſs ſphere: this ſphere is to be turned gently round its axis, till the whole ſurface is covered; the reſt being reſerved for future uſe. If the ſphere were of coloured glaſs, the *mirrour* will be ſo too. And in the ſame manner, may conick, elliptick, cylindrick, and other *mirrours* be made.

Concave MIRROURS are thoſe whoſe ſurface is concave; meaning *ſpherically concave*.

To prepare, or make *concave mirrours*; firſt, a mould is to be provided for caſting them: in order to this, take clay well dried, pulverize and ſift it; mix it up with water, and then ſtrain or filter it; with this work up horſe-dung and hair ſhred very ſmall, till the maſs be ſufficiently tough; to which, on occaſion may be added charcoal-duſt, or brick-duſt well ſifted. Two coarſe moulds are to be prepared of a gritty ſtone, the one concave, the other convex, which are to be ground on one another, with wet ſand between, till ſuch time as the one perfectly fits the other. By this means a perfect ſpherical figure is acquired. — The maſs prepared before is now to be extended on the table by means of a wooden roller, till it be of a thickneſs proper for the *mirrour*; and then being ſtrewed with brick-duſt, to prevent its ſtriking, it is laid over the convex mould, and ſo gets the figure of the *mirrour*. When this is dry it is covered with another lay of the ſame maſs; which once dried, both covers, or ſegments of the hollow ſphere, made of clay, are taken off. The innermoſt of the two being laid aſide, the ſtone mould is anointed with a pigment prepared of chalk and milk, and the outer cover again put over it. — Laſtly, the joining being covered over with the ſame clay whereof the cover is formed; the whole mould is bound together with an iron wire, and two holes cut through the cover, the one for the melted matter of the *mirrour* to be poured through, the other for the air to eſcape at, to prevent the *mirrour* being ſpoiled with bubbles. The mould thus prepared, eight parts of copper, one of *Engliſh* tin, and five of marcaſite, are melted together; a little of the mixture is taken out with a ladle, and if it be too red when cold, more tin is put in, if too white, more copper: the maſs is then poured into the mould before prepared, and ſo aſſumes the figure of a *mirrour*. — Some with ten parts of copper mix four of *Engliſh* tin, a little antimony and ſal ammoniack, ſtirring the maſs about as long as any fumes ariſe from it. Others have other compoſitions; many of which are deſcribed by *Shutters*, and *Zahnius*. The *mirrour* being thus caſt, is cemented to a wooden frame, and thus worked to and fro over the convex ſtone mould, firſt with water and ſand; and laſtly without ſand, till it be fit for poliſhing. The ſtone mould is then cover'd with paper, and that ſmear'd over with tripoli-duſt, and calx of tin: over which the *mirrour* is worked to and fro, till it has got a perfect poliſh. And in the ſame manner are glaſs *mirrours* poliſhed, excepting that the convex ſurface is there worked in the concave mould. When the *mirrours* are very large, they are fixed on a table, and firſt ground with a gritty ſtone, then with pumice, then with fine ſand, by means of a glaſs, cemented to a wooden frame; and laſtly, rubbed with calx of tin, and tripoli-duſt, by a wet leather. — For *concave mirrours* of glaſs, the mould is uſually made of alabaſter: the reſt as in metal *mirrours*.

Amongſt the laws and phænomena of *concave mirrours*, we find that, 1. If a ray falls on a concave *mirrour*, under an inclination of 60 degrees, and parallel to the axis; the reflected ray will concur with the axis in the pole of the glaſs. If the inclination of the incident ray be leſs than 60 degrees, the reflected ray will concur with the axis, at a diſtance leſs than a fourth part of the diameter. And univerſally, the diſtance of the point, wherein the ray concurs with the axis, from the center, is to half the radius, in the ratio of the whole ſine, to the coſine of inclination.

Hence it is gather'd by calculation, that in a concave ſpherical *mirrur*, whoſe breadth ſubtends an angle of ſix degrees, parallel rays meet after reflection, in a part of the axis leſs than one thouſand four hundred fifty ſeventh part of the radius: if the breadth of the concave *mirrour* be 6, 9, 12, 15, or 18 degrees; the part of the axis wherein the parallel rays meet, after reflection is leſs than $\frac{1}{1457}$, $\frac{1}{652}$, $\frac{1}{361}$, $\frac{1}{226}$, $\frac{1}{154}$, of the radius.

And

And on this principle it is that *burning-glaſſes* are built. For ſince the rays diffuſed through the whole ſurface of the concave *mirrour*, after reflection are contracted into a very ſmall compaſs; the light and heat of the parallel rays muſt be prodigiouſly increaſed thereby, *viz.* in a duplicate ratio of the breadth of the *mirrour*, and the diameter of the circle, wherein all the rays are collected: and ſince the ſun's rays are, as to any purpoſes on earth, parallel, no wonder concave *mirrours* ſhould burn with ſuch violence.

Among the antients the *burning mirrours* of *Archimedes* and *Proelles* are eminent; by one of which the *Roman* ſhips beſieging *Siracuſe*, under the command of *Marcellus*, according to the relations of *Zonaras*, *Tzetres*, *Galen*, *Euſtathius*, &c. and by the other the navy of *Vitalian* beſieging *Bizantium*, according to the ſame *Zonaras*, were burnt to aſhes. Among the moderns the moſt remarkable burning *mirrours* are thoſe of *Villette*, a *Frenchman*, *Settala*, and *Tſchirnhauſen*. *Settala*, canon of *Padua*, made a paraboliek *mirrour*, which, according to *Shottus*, burnt pieces of wood at the diſtance of 15 or 16 paces. M. *Tſchirnhauſen*'s mirrour is at leaſt equal to the former, both in bigneſs and effect. The following things are noted of it in the *Acta Eruditorum*: 1. Green wood takes fire inſtantaneouſly, ſo as a ſtrong wind cannot extinguiſh it. 2. Water boils immediateiy, and eggs in it are preſently edible. 3. A mixture of tin and lead three inches thick drops preſently, and iron or ſteel plate becomes red-hot preſently, and a little after burns into holes. 4. Things not capable of melting, as ſtones, bricks, &c. become red-hot like iron. 5. Slates become firſt white, then a black glaſs. 6. Tiles are converted into a yellow glaſs, and ſhells into a blackiſh yellow one. 7. A pumice-ſtone emitted from a volcano melts into white glaſs: And, 8. A piece of a crucible alſo vitrifies in eight minutes. 9. Bones are ſoon turned into an opake glaſs, and earth into a black one. The breadth of this mirrour is near three *Leipſick* ells, its focus two ells diſtant from it; it is made of copper, and its ſubſtance is not above half the thickneſs of the back of a knife. *Vilette*, a *French* artiſt of *Lyons*, made a large *mirrour*, bought by *Tavernier*, and preſented by him to the king of *Perſia*; a ſecond bought by the king of *Denmark*, a third preſented by the king of *France* to the Royal Academy; a fourth has been in *England*, where it was publickly expoſed. The effects, whereof, as found by Dr. *Harris* and Dr. *De aguliers*, are, that a ſilver ſix pence is melted in 7″ and ½; a king *George*'s halfpenny in 16″, and runs with a hole in 34; tin melts in 3″, caſt iron in 16″, ſlate in 3″, a foſſil-ſhell calcines in 7″, a piece of *Pompey*'s pillar at *Alexandria*, vitrifies in the black part in 50″, in the white in 54, copper ore in 8″: bone calcines in 4″, vitrifies in 33″. An emerald melts into a ſubſtance like a a turquois ſtone; a diamond weighing 4 grains, loſes ⅛ of its weight: the aſbeſtos vitrifies, as all other bodies will do, if kept long enough in the focus: but when once vitrified, the mirrour can go no further with them. This *mirrour* is 47 inches wide, and is ground to a ſphere of 76 inches radius; ſo that its focus is about 38 inches from the vertex. — Its ſubſtance is a compoſition of tin, copper, and tin-glaſs.

Wolfius tells us, that an artiſt of *Dreſden* made *burning mirrours* of wood, bigger than thoſe of M. *Tſchirnhauſen*, or *Villette*, which had effects at leaſt equal to any of them. *Traberus* teaches how to make *burning mirrours* of leaf-gold, *viz.* by turning a concave, laying its inſide equally with pitch, and covering that with ſquare pieces of gold, two or three fingers broad, faſtening them on, if need be, by fire. He adds, that very large *mirrours* may be made, of 30, 40, or more concave pieces, artfully joined in a wooden diſh or ſkuttle, the effects of which will not be much leſs than if the ſurface was continuous. *Zahnius* adds further, that *Newman*, an engineer, at *Vienna*, in 1699, made a mirrour of paſteboard, covered within ſide with ſtraw glewed to it; by which all kinds of metal, &c. were readily melted.

Cylindrical, *conical*, *parabolical*, and *elliptical* MIRROURS, or ſpecula, are thoſe terminated by a ſurface, reſpectively, *cylindrical*, *conical*, *parabolical*, and *ſphereidical*.

To *prepare* or *make cylindrical*, *conical*, &c. *Mirrours*, the proceſs is as follows. — For the *cylindrical* and *conical* ſort, if they are to be of glaſs, the method of preparing them is the ſame as that already laid down for convex *mirrours*. If of metal they are to be made after the manner of concave *mirrours*, only that the clay moulds there deſcribed require other wooden ones of the figure of the *mirrour*.—For *elliptical*, *parabolical*, and *hyperbolical mirrours*, the mould is to be thus prepared: on a wooden or brazen plane or table, deſcribe the figure of an *ellipſis*, *parabola*, or an *hyperbola*; which done, cut out the figure from the plane, with all the accuracy imaginable. To the elliptick figure fit an axis, with two fulcra to ſuſtain it, &c. and a handle to move it. Lay a quantity of the clay above-deſcribed under it, and turn about the axis with the handle, till the plane has turned or impreſſed the elliptical figure thereon. — The axis of the *parabolical*, or *hyperbolical* figure, is to be fixed at

at the vertex in ſuch manner as that it may always remain erect. This to be turned about as above, till it has given its own figure to the clay applied about it.—The part of the mould thus formed is to be dried, and either ſmeared over with fat, or ſprinkled with brick-duſt. Then a convex mould to be made, by putting a quantity of the ſame clay into a cavity thus formed. This latter is called the *male*, as the former the *female* mould.—The *male* mould being well dried, is to be applied within the *female*, in ſuch manner as only to leave the intended thickneſs of the mirrour between them. The reſt as for concave mirrours.

Beſides the *catoptrick machines* above-mentioned, there is another called *reflecting*, or *catoptrick teleſcope*, which inſtead of lens, conſiſts chiefly of *mirrours*, and exhibits remote objects by reflection inſtead of refraction.

This inſtrument is the invention of Sir *Iſaac Newton*. The firſt hint whereof, he took from Dr. *Gregory's opticks*.

For the conſtruction of this *reflecting teleſcope*, a tube A B C D, *Fig.* 22. muſt be provided, open in A D, and cloſed in B C, well blacked within ſide, and of a length equal to the diſtance of the focus; from the concave *ſpeculum* E F, to the bottom B C, is to be fitted a concave metallick *ſpeculum*, *a b*, poliſhed to the greateſt perfection; or rather, to have the objects clearer, and more diſtinct, let it be a glaſs *ſpeculum*, concave on its fore ſide, and equally convex on the hind ſide; for unleſs it be of the ſame thickneſs every where, it will reflect the images of objects tinged with a ſpurious colour; and indiſtinct. Towards the other end of the tube, is fixed an iron piece, to which is cemented a plain metallick *ſpeculum*; or, which is better, a triangular priſm of glaſs or cryſtal, whoſe upper angle is a right angle, the two others half right. The faces or planes that meet in the upper angle to be ſquare, and the third a parallelogram. This priſm is to be diſpoſed as that a ray reflected from the *ſpeculum*, paſſing through the middle of the face G M, may cut it at right angles; but be inclined to rectangle M N, in an angle of 45°. Its diſtance from the concave *ſpeculum* E F, is to be ſuch, as that the rays *a c* and *b d*, reflected from the concave *ſpeculum*, may, after a ſecond reflection, from the baſe of the priſm, concur in the point *e*; that is, the diſtance of the focus *e*, from the reflecting ſurface of the priſm, and the diſtance of that from the concave *ſpeculum*, is to be equal to the diſtance of the focus from the concave *ſpeculum*. In I is placed a plano-convex lens, whoſe focus is in *e*, that the reflected rays may enter the eye parallel. Laſtly, this lens is covered with a thin braſs or leaden plate, having a little round perforation therein, for the eye to look through, by which means all foreign rays are excluded, which would otherwiſe occaſion confuſion.

In the firſt teleſcope of this kind, which the inventor made, the ſemi-diameter of the concave metallick *ſpeculum*, was $12\frac{2}{3}$ digits, or tenths of an inch; from which, therefore, the focus was $6\frac{1}{2}$ digits diſtant. The diameter of the eye-glaſs was $\frac{1}{6}$ of a digit; ſo that it magnified the diameter of the object in the ratio of 1 to 38; but he found that objects were found ſomewhat obſcure hereby; on which account, he afterwards recommended glaſs *ſpecula* inſtead of metallick ones; adding that there is nothing more required to the perfection of this teleſcope, but that the art of poliſhing glaſs be brought to greater perfection; for that ſome inequalities, which do not hurt lenſes, are found to affect *ſpecula*, and prevent objects being ſeen diſtinctly.

The ſame author obſerves, that if the length of the inſtrument be 6 feet, and conſequently the ſemi-diameter of the concave *ſpeculum* 12, the aperture of the *ſpeculum* is to be 6 inches; by which means the object will be increaſed in the ratio of 1 to 200 or 300.

If it be longer or ſhorter, the aperture muſt be as the cube of the quadrato-quadrate root of the length, and its magnifying power as its aperture. The *ſpeculum* he orders to be an inch or two broader than the aperture.

Having ended what regards the doctrine of *catoptricks*, I'll paſs to that of *dioptricks*; which is properly the third branch of *opticks*.

DIOPTRICKS (formed of διὰ, *per*, *through*, and ὀπτομαι, *I ſee*) is the doctrine of refracted viſion, called alſo *anaclaſticks*: Its office being to conſider and explain the effects of light refracted by paſſing through different mediums, as air, water, glaſs, &c. and eſpecially lenſes.

To proceed with ſome order on this curious ſubject, I'll explain firſt the laws of *dioptricks*; and conclude by the application thereof, in the conſtruction of *teleſcopes*, *microſcopes*, and other *dioptrical* inſtruments.

The moſt eſſential of thoſe laws, are thoſe of *refraction*, which in *dioptricks* is in the inflection or bending of the rays of light, in paſſing the ſurfaces of glaſſes, lenſes, and other tranſparent bodies of different denſities.

The *general laws of refraction* are as follow: 1. *A ray of light in its paſſage out of a rarer, into a denſer medium*, e. gr. *out of air into glaſs, is refracted towards the perpendicular*, i. e. *towards the axis of refraction*.

Hence the refracted angle is leſs than the angle of

of inclination: and the angle of refraction less than that of incidence,

2. *The ratio of the sine of the angle of inclination, to the sine of the refracted angle, is fixed and constant*, viz. if the refraction be out of air into glass, it is found greater than as 114 to 76; but less than 115 to 76; that is, nearly as 3 to 2.

Zahnius and *Kircher* have found, that if the angle of inclination be 70°, the refracted angle will be 38°, 50′; on which principle, *Zahnius* has constructed a table of refractions out of air into glass, for the several degrees of the angle of inclination; a specimen whereof follows:

Angle of Inclination.	*Refracted Angle.*	*Angle of Refraction.*
10	0° 40′ 5″	0 19 55″
2	1 20 6	0 39 54
3	2 0 3	0 59 56
4	2 40 5	1 19 55
5	3 10 3	1 39 57

Angle of Inclination.	*Refracted Angle,*	*Angle of Refraction.*
10°	6° 39′ 16″	3° 20′ 44″
20	13 11 35	6 48 25
30	19 29 29	10 30 31
45	28 9 19	16 50 41
90	41 51 40	48 8 20

3. *When a ray passes out of a denser into a rarer medium*, e. gr. *out of glass into air, it is refracted from the perpendicular, or from the axis of refraction.*

4. *A line falling on a curve surface, whether concave or convex, is refracted after the same manner, as it fell on a plane, which is a tangent to the curve in the point of incidence.*

5. *If a right line cuts a refracting surface at right angles, and if from any point in the denser medium, be drawn a parallel to the incident ray, this will meet the refracted ray, at the less extreme of the parallel; and will be to it as the sine of the refracted angle, to the sine of the angle of inclination.*

Hence if B C, *Fig.* 25. pass out of glass into air, it is in a subsequialterate ratio to C D; if out of air into glass, into a sesquialterate ratio to C D.

Hence also, if light pass out of water into air; C B is in a subsesquitertian ratio to C D; if out of air into water in a sesquitertian.

Amongst the *laws of refraction in plane surfaces*, it is noted, that if the eye be placed in a rarer medium, an object seen in a denser medium, by a ray refracted in a plane surface, will appear larger than it really is. If the object be in a rarer, and the eye in a denser medium, the object will appear less than it is. And in each case the apparent magnitude, is to the real one, in a ratio compounded of the distance of the point, to which the rays tend before refraction, from the refracting surface, to the distance of the eye, from the same, and of the distance of the object, from the eye, to its distance from a point to which the rays tend before refraction.

Hence, 1. If the object A D, be very remote, F M will be physically equal to G M; and therefore the real magnitude M B, to its apparent one M H; or the distance of the eye from the refracting plane, to the distance of the point of convergence from the same plane.

Hence, 2. *Objects under water, to an eye in the air, appear larger than they are; and to fishes under water, objects in the air appear less than they are.*

And amongst the *laws of refraction in spherical surfaces, both concave and convex.* A ray of light D E (*Fig.* 19,) parallel to the axis of a denser sphere; after a single refraction in E, falls in with the axis in the point *f*, beyond the center C.

For the semi-diameter C E drawn to the point of *refraction* E, is perpendicular to the surface, and is therefore the axis of refraction: and therefore the ray D E will converge to the axis of the sphere A F; and will, therefore, at length concur with it; and that beyond the center C, in F, because the angle of refraction F E H, is less than the angle of inclination C E H.

2. If a ray H E (*Fig.* 23.) falls parallel to the axis F A, out of a rarer, on the surface of a spherically concave denser medium, the refracted ray E N will be driven from the point of the axis F; so as F E will be to F C, in the ratio of the sine of the angle of inclination, to the sine of the refracted angle.

And 3. If the ray H E (*Fig.* 22,) fall parallel to the angle A F, from a denser, upon the surface of a spherically concave rarer medium; the refracted ray will concur with the axis A F, in the point F; so as the distance of the point of concourse from the center, may be to the refracted ray in the ratio of the sine of the refracted angle, to the sine of the angle of inclination.

From this examen of the laws of refraction in *dioptricks*, in general; I'll pass to a more particular one, of those laws with respect to *lenses, telescopes, microscopes, prisms*, &c. beginning by the definition of *lens*, &c.

Lens, in *dioptricks*, properly signifies a small, oblong glass, of the figure of a *lentil*; but is extended to any *optick* glass, not very thick, which either

either collects the rays of light into a point, in their paſſage through it, or diſperſes them further apart, according to the laws of refraction.

Lenſes have various figures; that is, are terminated by various ſurfaces, from which they acquire various names. Some are plain on one ſide, and convex on the other; others convex on both ſides; both which are ordinarily called *convex lenſes*; though when we ſpeak accurately, the former are called *plano-concave*. Others again, are concave on both ſides; others are concave on one ſide, and convex on the other; which are called *convexo-concave*, or *concavo-convex lenſes*, according as the one or other ſurface is more curve, or a portion of a leſs ſphere.

It is to be here obſerved, that in every *lens* terminated in any of the afore-mentioned manners, a right line perpendicular to the two ſurfaces, is called the axis of the *lens*. Which axis, when both ſurfaces are ſpherical, paſſes through both their centers; but if one of them be plane, it falls perpendicularly upon that, and goes through the center of the other.

Lenſes are diſtinguiſhed, with regard to their manner of preparation, into *ground*, and *blown*.

Blown lenſes are little globules of glaſs, melted in the flame of a lamp or taper. The ſecret is now found of making theſe exquiſitely ſmall, ſo as ſome of them do not exceed in diameter, the ſixth part of a line, which are found to magnify objects ſeveral millions of times.

Note, alſo, That as to the manner of grinding *lenſes*, I have explained it in my treatiſe of *glaſs-grinding*, under the letter G.

Amongſt the *laws of refraction*, with regard to *lenſes*, thoſe of *convex-lens*, and the effects depending thereon, it is obſerved that,—1. A ray of light near the axis and parallel thereto, (*table opticks*, *Fig.* 25,) ſtriking on the plain ſurface of a *plano-convex lens*, directly oppoſite to the luminous body, after refraction concurs with the axis in the point F, and if C be the center of the convexity, C F will be to F L, that is, from the diſtance of the center from the point of concourſe, or focus, will be to the diſtance of the center in the convex ſurface, in the ratio of the refraction.

For the plain ſurface being directly oppoſed to the luminous body, the ray E G is perpendicular to A B, and therefore will paſs unrefracted to H: thus it ſtrikes on A H B, ſtill parallel to the axis; and therefore coming out of a denſer medium into a rarer, will meet with the axis of the lens in *b*; and ſo as that C F will be to F L, in the ratio of the ſine of the refracted angle, to the ſine of the angle of inclination,

If the refraction be out of a glaſs lens into air, C F: E L :: 3:2, and therefore F L = 2 C L, that is, parallel rays, near the axis, will concur with it at the diſtance of the diameter.—Again, if the refraction were out of a water lens, *i. e.* out of a *plano-convex lens* filled with water, C F: E L :: 4: 3, and therefore F L = 3 C L, *i. e.* parallel rays nearer the axis, will concur with it at the diſtance of half the diameter. So that if a lighted candle be placed in the focus of a *plano-convex lens*, that is, in the point *f*, diſtant from the ſurface of the lens A L B, by the length of the diameter; and from the ſurface of the water *lens*, by half the diameter, its rays, after refraction, will become parallel.

2. If the ray K L (*Fig.* 24.) near the axis of a *plano-convex lens*, and parallel thereto, ſtrikes on its convex ſurface A O H B, after a double refraction, it will meet the axis in F; ſo as that H G will be to G C, and G F to F H, in the ratio of the refraction.

For the ray K I, parallel to the axis E G, by virtue of the firſt refraction in I, will tend to the point G, ſo as G H will be to G C in the ratio of the ſine of the angle of inclination, to the ſine of the refracted angles: therefore by virtue of the ſecond refraction in L, it will concur with the axis in F; ſo as G D will be to F D, in the ratio of the ſine of the refracted angle, to the ſine of the angle of inclination.

3. If a luminous body be placed in a focus behind a lens, whether plano-convex, or convex on both ſides, or, whether equally or unequally, the rays after refraction become parallel.

4. The images of objects, oppoſed in any manner to a convex lens, are exhibited invertedly in its focus.

5. If a concave *mirrour* be ſo placed, as that an inverted image, formed by refraction through a lens, be found between the center and the focus, or even beyond the center, it will again be inverted by reflection, and ſo appear erect in the firſt caſe beyond the center; and in the latter, between the center and the focus. On theſe principles is built the *camera obſcura*.

Camera obſcura, is a machine or apparatus, repreſenting an artificial eye; whereon the images of external objects, received through a double convex glaſs, are exhibited diſtinctly, and in their native colours, on a white matter placed within the machine, in the focus of the glaſs.

6. The diameter of the image of an object delineated beyond a convex lens, is to the object itſelf in the ratio of the diſtance of the image to that of the object.

7. If the eye be placed in the focus of a convex lens, an object viewed through it appears erect,

and enlarged in the ratio of the diſtance of the object from the eye, to that of the eye from the lens, if it be near; but infinitely, if remote.

The laws of *concave lens* are as follows. 1. If parallel rays ſtrike on a plano-concave lens K L, *Fig.* 7. and F C be to F B in the ratio of refraction, the rays will diverge from the axis, and the point of divergency, or diſperſion, called the virtual focus, will be F.

For the ray H I, parallel to the axis, is perpendicular to K L, and will therefore paſs unrefracted to E. Wherefore F C being to F B in the ratio of refraction, F will be the virtual focus.

If then, the lens be glaſs, F B = 2 B C, *i. e.* the virtual focus F will be diſtant from the lens K L, by the ſpace of the diameter 2 B C.

If the refraction be in water, F B = 3 B C, *i. e.* the virtual focus F, will be diſtant from the lens K L, a diameter and a half 3 B C.

2. If the ray A E, parallel to the axis F P, ſtrike on a lens concave on both ſides; and both F C be to F B, and I P to P H, in the ratio of refraction; and F P: P H:: F B: B G; G will be the point of diſperſion, or the virtual focus, *Fig.* 5.

If therefore the refraction be in a glaſs lens, the ſums of the ſemi-diameters C B and H I, will be to the diameter of the concavity of either 2 H I, as the ſemi-diameter of the other C B, to the diſtance of the virtual focus, from the lens B G.

Focus is, in *Opticks*, a point wherein ſeveral rays concur, and are collected; either after having undergone refraction or reflection. In *dioptricks*, *focus* is the point wherein refracted rays, render'd convergent by refraction, do concur or meet, and croſs the axis. The ſame point is alſo called the *point of concourſe*, or *concurrence*. And in *catoptricks*, *focus*, is a point wherein the rays reflected from the ſurface of a mirrour or ſpeculum, and by reflection render'd convergent, do concur, or meet.

The rules for finding the *foci* of glaſſes, are theſe: to find the focus of a convex ſpherical glaſs, being of a ſmall ſphere, apply it to the end of a ſcale of inches, and decimal parts, and expoſe it before the ſun; upon the ſcale you will have the bright interſection of the rays meaſured out; or expoſe it in the hole of a dark chamber; and where a white paper receives the diſtinct repreſentation of diſtinct objects, there is the focus of the glaſs. For a glaſs of a pretty long focus, obſerve ſome diſtant object thro' it, and recede from the glaſs, till the eye perceives all in confuſion, or the object begins to appear inverted; here the eye is in the focus. For a plano-convex glaſs, make it reflect the ſun againſt the wall, you will on the wall perceive two ſorts of light; one more bright within, another more obſcure; withdraw the glaſs from the wall, till the bright image is at its ſmalleſt; the glaſs is then diſtant from the wall about the fourth part of its focal length. For a double convex; expoſe each ſide to the ſun in like manner; and obſerve both the diſtances from the wall. The firſt diſtance is about half the radius of the convexity turned from the ſun; and the ſecond, about half the radius of the other convexity. Thus we have the radii of two convexities; whence the focus is found by this rule: as the ſum of the radii of both convexities, is to the radius of either convexity, ſo is the double radius of the other convexity, to the diſtance of the focus.

A TELESCOPE is an optical inſtrument, conſiſting of ſeveral glaſſes, or *lens*, fitted into a tube, thro' which remote objects are ſeen, as if nigh at hand.

In *teleſcopes*, the lens or glaſs turned towards the object, is called the *object-glaſs*; and that next the eye, the *eye-glaſs*; and if the *teleſcope* conſiſts of more than two lenſes, all but that next the object, are called *eye-glaſſes*.

Teleſcopes are of ſeveral kinds diſtinguiſhed by the number and form of their lenſes or glaſſes; and denominated from their particular uſes; ſuch as the *terreſtrial* or *land teleſcope*; the *celeſtial* or *aſtronomical teleſcope*; to which may be added, the *Galilean* or *Dutch teleſcope*, the *reflecting teleſcope*, and the *ærial teleſcope*.

The *Galilean* or *Dutch teleſcope*, is a *teleſcope*, conſiſting of a convex *object-glaſs*, and a concave *eye-glaſs*.

For the conſtruction of a *Dutch teleſcope*; in a tube prepared for the purpoſe, at one end is fitted a convex object lens, either a plain convex, or convex on both ſides, but a ſegment of a very large ſphere: at the other end is fitted an eye-glaſs, concave on both ſides, and the ſegment of a leſs ſphere; ſo diſpoſed, as to be the diſtance of the virtual focus, before the image of the convex lens.

In an inſtrument thus framed, all people, except *myopes*, or thoſe *ſhort ſighted*, muſt ſee objects diſtinctly in an erect ſituation, and increaſed in the ratio of the diſtance of the virtual focus of the eye-glaſs to the diſtance of the focus of the object-glaſs.

But for *myopes* to ſee objects diſtinctly through ſuch an inſtrument, the eye-glaſs muſt be ſet nearer the object-glaſs. The reaſon of theſe effects will appear from what follows: For,

1. Since it is far diſtant objects that are to be viewed with a *teleſcope*, the rays proceeding from the ſame point of the object, will fall on the object-glaſs parallel, and conſequently by their refraction through the convexity, will be thrown converging on the eye-glaſs; but by their refraction through the concavity

vity hereof, they will be again rendered parallel, and in ſuch diſpoſition will enter the eye.—But all, excepting *myopes*, ſee objects diſtinctly by parallel rays.

2. Suppoſe A (Fig. 30.) to be the focus of the object-glaſs; and ſuppoſe A C, the fartheſt rays on the right hand of the object that paſſes through the tube: after refraction it will become parallel to the axis B I, and conſequently after a ſecond refraction through the concave lens, will diverge from the virtual focus. Wherefore ſince all the rays coming from the ſame extreme, to the eye placed behind the concave lens, are parallel to L E; and thoſe from the middle of the object parallel to F G; the middle point of the object will be ſeen in the axis G A; and the right extreme, on the right ſide, *viz.* in the line L N, a parallel thereto; that is, the object will be erect: which is the ſecond point.

3. Since all right-lines, parallel to L N, cut the axis under the ſame angle, the ſemi-diameter of the object will be ſeen through the *teleſcope*, under the angle A F N, or E F I: the rays L E, and G I, entring the eye in the ſame manner, as if the pupil was placed in F. If now the naked eye were in A, it would ſee the ſemi-diameter of the object under the angle *c* A *b* or C A B. But ſince the object is ſuppoſed very remote, the diſtance A F, in reſpect hereto is nothing, and therefore the naked eye, even in F, would ſee the ſemi-diameter of the object under an angle equal to A.

The ſemi-diameter of the object therefore, ſeen with the naked eye, is to that ſeen through the *teleſcope*, as I M to I E. But it is demonſtrated, that I M: I E:: I F: R B; that is, the ſemi-diameter ſeen with the naked eye, is to that viewed through the *teleſcope*, in the ratio of the diſtance of the virtual focus of the eye-glaſs F I, to the diſtance of the focus of the object-glaſs A B; which was the third point.

Laſtly, *myopes* have their retina too far from the cryſtalline humour; and diverging rays concur at a greater diſtance than parallel ones; and thoſe that were parallel become diverging, by bringing the eye-glaſs nearer the object-glaſs; by means of ſuch approach, *myopes* will ſee objects diſtinctly through a *teleſcope*; which is the fourth point.

An *aſtronomical* TELESCOPE, is a *teleſcope* conſiſting of an object-glaſs and an eye-glaſs, both convex. It has its name from its being wholly uſed in aſtronomical obſervations.

For the conſtruction of an *aſtronomical teleſcope*. The tube being prepared, an object-glaſs, either plano-convex, or convex on both ſides, but to be a ſegment of a large ſphere, is fitted in at one end; at the other end, an eye-glaſs, convex on both ſides, which is the ſegment of a ſmall ſphere, is fitted at the common diſtance of the foci.

The theory of this *teleſcope* is as follows. An eye placed near the focus of the eye-glaſs, will ſee objects diſtinctly, but inverted and magnified in the ratio of the diſtance of the focus of the eye-glaſs, to the diſtance of the focus of the object-glaſs.

For, 1. Since it is very remote objects are viewed through *teleſcopes*, the rays from one point of the object fall parallel on the object-glaſs; and conſequently after refraction, will meet in a point behind the glaſs, which point is the focus of the eye-glaſs. From this point they begin to diverge, and fall diverging on the eye-glaſs, where, being refracted, they enter the eye parallel.

Hence, as all but *myopes*, ſee diſtinctly by parallel rays, a *teleſcope* thus diſpoſed, will exhibit remote objects diſtinctly.

Suppoſe the common focus of the lens's in F, *Fig.* 32. and make A B = B F. Since one of the rays A C, proceeding from the right ſide of the object, paſſes through A; the ray C E will be parallel to the axis A I, and therefore after refraction in the eye-glaſs, will fall in with it in its focus G. Since then, the eye is placed near it, and all the other rays proceeding from the ſame point of the object with E G, are refracted parallel thereto; the point in the right ſide of the object, will be ſeen in the right line E G.

After the like manner it appears, that the middle point of the object is ſeen in the axis G B, ſo that the object appears inverted.

3. From what has been already ſhewn, it appears, that the ſemi-diameter of the object will be ſeen thro' the *teleſcope*, under the angle E G I, which to the nake eye placed in A, is ſeen under the angle *b* A *c*. Suppoſe now I F equal to the diſtance of the focus I G; ſince the right angles at I are equal, E G F = E F I. Therefore, drawing F M, parallel to A C, we ſhall have I F M = B A C.—The ſemi-diameter, therefore, viewed with the naked eye, is to that viewed through the *teleſcope*, as I M to I E; draw K E parallel to F M we ſhall have I M: I E:: I F: I K; but by reaſon of that parallelism of the lens, C E = B I = B F + F I = A B + F I; and by reaſon of the parallelism of the right lines C A and E K, C E = A K, therefore B I = A K, conſequently A B = I K. And therefore I M: I E:: I F: A B; that is, the ſemi-diameter ſeen with the naked eye, is to the ſemi-diameter viewed through the *teleſcope*, in the ratio of the diſtance of the focus of the eye-lens I F, to the diſtance of the focus of the object-glaſs A B.

Land TELESCOPE, or *day teleſcope*, is a teleſcope conſiſting of more than two lenſes, commonly of a

convex object-glaſs, and three convex eye-glaſſes; or, a *teleſcope* that exhibits objects erect, yet different from that of *Galileo*.—It has its name from being uſed to view objects in the day time, on or about the earth.

To conſtruct a *land* or *day teleſcope*.—A tube being provided, fit in an object-glaſs, which is either convex on both ſides, or plano-convex, and a ſegment of a large ſphere: to this add three eye-glaſſes, all convex on both ſides, and ſegments of equal ſpheres, diſpoſing them in ſuch manner, as that the diſtance of any two may be the aggregate of the diſtances of their foci.

Then will an eye applied to the laſt lens, at the diſtance of its focus, ſee objects very diſtinctly, and magnified in the ratio of the diſtance of the focus of one eye-glaſs, to the diſtance of the focus of the object glaſs.

The *optical principles* whereon *teleſcopes* are founded, are contained in *Euclid*. From this I'll paſs to the *microſcope*.

A Microscope, is a *dioptrical* inſtrument, by means whereof very minute objects are repreſented exceedingly large, and viewed very diſtinctly, according to the laws of refraction.

Microſcopes are properly diſtinguiſhed into *ſimple*, or *ſingle*; and *compound* or *double*.

Single microſcopes are thoſe which conſiſt of a ſingle lens, or a ſingle ſpherule.

Compound microſcopes conſiſt of ſeveral lenſes duly combined.

With regard to the foundation and theory of *ſingle microſcopes*.—If an object A B (*Fig.* 34.) be placed in the focus of a ſmall convex lens, or a *ſimple microſcope* D E, and the eye be applied cloſe to the other ſide of the *microſcope*, the object will be ſeen diſtinct in an erect ſituation, and magnified in the ratio of the diſtance of the focus, to the diſtance wherein objects are to be placed to be ſeen diſtinctly with the naked eye.

For the object A B, being placed in the focus of the convex lens D E, the rays iſſuing from the ſeveral points thereof after refraction, will be parallel to each other. Conſequently the eye will ſee it diſtinctly, by virtue of what we have proved in ſpeaking of *teleſcopes*.

The laws of *ſimple microſcopes*, are,—1. That *ſimple microſcopes* magnify the diameter of the object A B, in the ratio of the diſtance of the focus F C to an interval of eight digits; *v. gr.* if the ſemi-diameter of a lens convex on both ſides be half a digit, A B; 1 K = ½ 8 = 1 : 16, that is, the diameter of the object will be increaſed in a ſedecuple proportion, or as ſixteen to one.

2. Since the diſtance F H is conſtant, *viz.* eight digits, by how much diſtance of the focus F C is ſmaller, ſo much the ſmaller ratio will it have to F H; conſequently the diameter of the object will be ſo much the more magnified.

3. Since in the plano-convex lens, the diſtance of the focus is equal to the diameter; and in lenſes convex on both ſides, to the ſemi-diameter; *ſimple microſcopes* will enlarge the diameter ſo much the more, as they are ſegments of ſmaller ſpheres.

4. If the diameter of the convexities of a plano-convex lens, and a lens convex on both ſides, be the ſame, *viz.* = 1; the diſtance of the focus of the firſt will be 1, of the ſecond ½; conſequently the ſemi diameter of the object A B, will be to the apparent one in the firſt caſe as 1 to 8, in the latter as ½ to 8, *i. e.* as 1 to 16. A lens therefore convex on both ſides magnifies twice as much as a plano-convex.

As the whole depends on the juſt and ſteady ſituation of objects with regard to the lens, various methods have been contrived to that end; whence we have ſeveral kinds of *microſcopes*; the moſt ſimple is as follows.

1. A B (*Fig.* 34.) is a little tube, to one of whoſe baſes B C, is fitted a plain glaſs, to which an object, *viz.* a gnat, wing of an inſect, down, or the like, is applied: to the other baſe, A D, at a proper diſtance from the object is applied a lens convex on both ſides, whoſe ſemi-diameter is about half an inch. The plain glaſs is turned to the ſun, or the light of a candle, and the object is ſeen magnified: and if the tube be made to draw out, lenſes of different ſpheres may be uſed.

Again, a lens convex on both ſides, is incloſed in a cell A C (*Fig.* 35.) and by a ſcrew H, there faſtened a croſs; through the pedeſtal C D paſſes a long ſcrew, by means whereof, and the female ſcrew I, a ſtyle or needle fixed perpendicularly to its extreme, is kept firm at any diſtance from the lens. In E is a little tube, on which, and on the point G, the various objects are to be diſpoſed; there may be lenſes of various ſpheres applied.

2. But the *microſcope*, which is found to anſwer the end beſt is as follows; A B, *Fig.* 39. is a round braſs tube, whoſe exterior ſurface is formed into a ſcrew of a length ſomewhat leſs than the diſtance of the focus of a glaſs convex on both ſides, uſed here for illuminating the object, and fitted to its baſe A C, by a ring with a ſcrew in it D E.

F G is another braſs tube, ſomewhat wider than the firſt, and open each way for an object to be applied to the *microſcope*. To its upper baſe G H, is faſtened a ſpring of ſteel wire, twiſted into a ſpiral I, whereby an object placed between two round

plates,

plates, or ſlices, K and L, in the manner hereafter mentioned, is by means of the ſcrew B C brought, to the microſcopical lens (or magnifying glaſs, whereof there are ſeveral) and kept firm in its place, to the baſis H G, which has a female ſcrew M, are fitted cells N, with a male ſcrew O, wherein lenſes of various ſpheres guarded by ferrils, are included. In P is a female ſcrew, by which an ivory handle P Q is faſtened to the *microſcope*.

In the ivory ſlice T are round holes, in which are fitted little circles of *Muſcovy* talc for objects, eſpecially ſmall and pellucid ones, as little inſects, or the wings, ſcales, *&c.* of larger to be faſtened to.

When live inſects are to be viewed, they are covered with the braſs ſlice Y, which is put in a little ſquare braſs bed, perforated with a hole X; and the ſame ſlice, whether alone, or encloſed in the bed, being laid between the round plates K and L, is brought to the lens by means of the ſcrew A B, till the object may be diſtinctly viewed.

If other pellucid oblong objects are to be viewed, as down, cuticle, *&c.* inſtead of the ſlice above, is uſed the inſtrument, mentioned above for viewing wings of flies; whoſe ſtructure is manifeſt by inſpection.

There are other inſtruments in the apparatus of the *microſcope*, as little tongs, *&c.* for taking up ſmall objects, a glaſs tube for viewing the circulation of the blood in fiſhes, *&c.* which need no deſcription.

What has been ſaid hitherto, is to be underſtood of *lenticular microſcopes*; for ſpherical ones, their doctrine will be underſtood from what follows.

In an object AB (*Fig.* 40.) be placed in the focus of a glaſs ſpherule F, and the eye be behind it, *v. gr.* in the focus G, the object will be ſeen diſtinct in an erect ſituation, and magnified, as to its diameter, in a ratio of ¼ of the diameter E I, to the diſtance at which objects are to be placed, to be ſeen diſtinctly with the naked eye.

As to *water microſcopes*.—M. *S. Gray*, and after him *Wolfius*, and others, have contrived *water microſcopes*; conſiſting of ſpherules or lenſes of water inſtead of glaſs, fitted up ſomewhat after the manner above-mentioned.

As to the theory of *compound*, or *double microſcopes*.——Suppoſe an object-glaſs E D, *Fig.* 43. the ſegment of a very ſmall ſphere, and the object A B placed without the focus F.

Suppoſe an eye-glaſs G H, convex on both ſides, and the ſegment of a ſphere greater (though not too great) then that of D E, and let it be ſo diſpoſed behind the object, as that if C E : C L : : C L : C K, the focus of the eye-glaſs may be in K.

Laſtly, ſuppoſe L K : L M : : L M : L I.

If then O be the place wherein an object is ſeen diſtinct with the naked eye; the eye in this caſe being placed in I, will ſee the object A B in an inverted ſituation, and magnified in a compound ratio of M K to L K and L C to C O; as is proved from the laws of dioptricks.

The moſt commodious *double microſcope* is of the contrivance of Mr. *Marſhal*, an *Engliſhman*. In this the eye-glaſſes are placed in the tube at A and B (*Fig.* 47) and the object-glaſs at C, the little pillar D E is turned by means of a ball E, movable in the ſocket F; and thus the *microſcope* is accommodated to any ſituation. The ſame pillar is divided into as many parts, 1, 2, 3, 4, 5, *&c.* as there are lenſes of different ſpheres to be uſed in viewing different objects; ſo that the diſtance of the object from the object-glaſs may be found without any trouble. But as it is ſcarce exactly enough determined this way, the tube may be brought nearer the object at diſcretion, by means of the ſcrew G H.

The objects are either laid on the circle I, or fitted to proper inſtruments, having their points or ſtiles paſſing through the little tube L M.

Laſtly, to illuminate the object, a lens convex on both ſides, is diſpoſed in a convenient ſituation.

There are reflecting *microſcopes*, which magnify by *reflection*, as the above-mentioned ones do by refraction. The ſtructure of ſuch a *microſcope* may be conceived thus; near the focus of a common ſpeculum ABC (*Fig.* 48.) place a minute object C, that its image may be formed larger than itſelf in D. To the ſpeculum join a lens convex on both ſides E F, ſo as the image D may be in its focus. The eye will here ſee the image inverted, but diſtinct and enlarged; conſequently the object will be larger if viewed through the lens alone. Sir *Iſaac Newton* invented this *microſcope*.

The next thing, which occur, are *ſpectacles*.

SPECTACLES are an optick machine, conſiſting of two lenſes ſet in horn or other matter, and applied on the noſe, to aſſiſt in defect of the organ of ſight.

Old people, and all preſbytæ, uſe *ſpectacles* of convex lenſes, to make amends for the flatneſs of the eye.

Short-ſighted people, or *myopes*, uſe concave lenſes, to keep the rays from converging ſo faſt, through the great roundneſs of the eye, as to make them meet ere they reach the retina.

Spectacles were certainly unknown to the antients; yet are they not of ſo late a date as the teleſcope. *Franciſco Ridi*, in a very learned treatiſe on *ſpectacles*, will have them to have been invented in the 13th century, between the years 1280,

1280, and 1311; and adds, that *Alexander Deſpina*, a monk of the order of predicants of St. *Catherine*, at *Piſa*, firſt communicated the ſecret, which was of his own invention; upon learning that another perſon had it as well as himſelf. The hiſtory is wrote in the chronicles of that convent.

Du Conge, however, carries the invention of *ſpectacles* farther back; aſſuring us, that there is a *Greek* poem in manuſcript, in the king of *France*'s library, which ſhews, that *ſpectacles* were in uſe in the year 1150.

From this I'll paſs to the deſcription of a *priſm*, in *dioptricks*; and to the explication of the phænomena thereof.

PRISM, in *dioptricks*, is a glaſs in form of a triangular priſm, much uſed in experiments about the nature of light and colours.

Priſm, in *Geometry*, whence this borrows its name, is an oblong ſolid or body, contained under more than four planes, and whoſe baſes are equal, parallel, and equally ſituated.

The phænomena and uſe of the *priſm*, ariſe from its ſeparating the rays of light in their paſſage thro' it.

The more general of theſe phænomena are as follow:

1. The ſun's rays tranſmitted thro' a *priſm* to an oppoſite wall, project an image like the rainbow, of various vivid colours; the chief whereof are red, yellow, green, blue, and violet.

The reaſon is, that the various colour'd rays, which were before mixed and blended together, are now, in virtue of their different refrangibilities, ſeparated by refraction, in paſſing thro' the *priſm*, and thrown each colour by itſelf.

For the blue rays, *v. gr.* repreſented by the dotted lines, *Fig.* 50. beginning to be ſeparated from the reſt in the ſide *c a*, of the *priſm a b c*, by the firſt refraction in *d d*, are again ſeparated further in the other face of the *priſm b c*, by a ſecond refraction, the ſame way in *e e*; whereas in a plain glaſs, or even in a *priſm* in a different poſition, the blue rays ſeparated by the firſt refraction, are again mixed by the ſecond refraction, at the other ſurface, which is made a contrary way.

2. The image thus projected, is not round; but when the angle of the *priſm* is 60 or 65 deg. about five times as long as broad.

3. Thoſe rays which exhibit the yellow colour, ſwerve more from the rectilinear courſe, than thoſe which exhibit the red; and the green more than the yellow; and the violet moſt of all.

4. If the *priſm*, through which the rays are tranſmitted, be turned about its axis; ſo as the red, yellow, green, *&c.* rays, be received in order on another *priſm* about 12 feet diſtant from the former, through a little hole, and thence projected further, the yellow, red, *&c.* rays, though they fall in the ſame manner, on the ſecond *priſm*, yet will not be projected on the ſame place as the red, but will be deflected further that way towards which the refraction is.

And if, in lieu of the ſecond priſm, they be received on a lens a little convex; the yellow, green, *&c.* rays, will be collected each in its order, into a nearer focus than the red ones. The reaſon of which two laſt phænomena is, that the yellow rays are refracted more than the red ones; the green ones more than the yellow ones, and the violet ones moſt of all.

5. The colours of colour'd rays well ſeparated, can neither be deſtroyed, nor in any manner alter'd by repeated refractions through a number of *priſms*, nor by paſſing through an illumined ſpace, nor by their mutual decuſſations, nor by the neighbourhood of the ſhade, nor by being reflected from any natural bodies.

6. All coloured rays collected together in any manner, either by ſeveral *priſms*, or a convex lens, or concave ſpeculum, form whiteneſs; but being again ſeparated after decuſſation, each exhibits its proper colour.

7. If the ſun's rays fall very obliquely on the inner ſuperficies of a *priſm*, the rays reflected will be violet; thoſe tranſmitted, red.

8. If there be two *priſms*, the one full of a red liquor, the other of a blue one; the two joined together will be opake; though, if both be filled either with a blue or a red liquor, they will together be tranſparent: for the one tranſmitting none but blue, the other none but red rays, the two together will tranſmit none at all.

9. All natural bodies, eſpecially white ones, viewed through a *priſm* held to the eye, ſeem fringed or hammed on one ſide, with red and yellow, on the other with blue and violet.

10. If two *priſms* be ſo placed, that the red of the one, and the purple of the other, meet on a paper encompaſſed with darkneſs, the image will be pale; but viewed through a third *priſm*, held to the eye at a due diſtance, will appear double, red, and purple.

And if two kinds of powder, the one perfectly red, the other blue, be mixed, a little body being covered thick with the mixture, will exhibit a double image, the one red, the other blue, through a *priſm* applied to the eye.

11. If the rays tranſmitted through a convex lens be received on a paper before they meet in the focus, the confine of light and ſhadow will ſeem tinged with a red colour; if beyond the focus, with a blue.

12. If

12. If the rays about to be tranſmitted through one part of the pupil, be intercepted by the oppoſition of ſome opake body near the eye, the extremes of bodies laying beyond it, will ſeem tinged with colours, as is ſeen through a *priſm*, though leſs vivid.

Euclid has wrote on the antient *opticks*, and *catoptricks*: *dioptricks* were unknown to them. *F. Honorat. Fabri* has an abridgment of *opticks*, *catoptricks*, and *dioptricks*: Father *Eſchinard* has given a century of problems in *opticks*; *Vitellio* and *Alhazen*, have performed well on the elements of *opticks*. Father *Kircher* has a large volume on the ſecrets of *opticks*, of light and ſhadow, and their ſurprizing effects, which paſs on the people for magick. We have alſo *L'optique* and *catroptrique* of father *Merſenne*, *Paris* 1651. *Dioptrique Oculaire* of father *Cherubin*, *Paris* 1671. *fol. Chriſtop. Cheiveri Optica*, *London* 1658. *Jacobi Gregorii Optices*. *Barrovii Lectiones Opticæ*, *London* 1663. *Joh. Bapt. Porta*, *De refractione Optices*, *London* 1669. *Principes generales de l'optique*, by M. *Leibneitz*, in the *Leipſick* acts, 1642. *L'Occhiale a l'occhia*, or *dioptrica practica*, *Carol. Anton. Manimé*, *Bologna* 1660, 4*to*. Sir *Iſaac Newton*'s *opticks*, *Latin* and *Engliſh* 4*to*. and 8*vo*. &c.

PAINTING.

PAINTING is the art of repreſenting on a flat ſuperficies, by the duct of draught, and the degrees of colours, all ſorts of viſible objects.

This definition contains three things, *viz.* the *draught*, the *colours*, and the *compoſition*; and tho' this laſt part does not appear expreſſed in a very clear manner in my definition, it can, notwithſtanding, be underſtood by theſe laſt words, *viſible objects*, which contains the matter of the ſubjects, which the painter propoſes to repreſent.

The *compoſition* contains two things, *viz.* the *invention* and the *diſpoſition*. By the *invention*, a painter muſt find and introduce into his ſubject, the objects which he judges moſt proper to expreſs and adorn it. And by the *diſpoſition*, he muſt place them in a manner, the moſt advantageous to draw a grand effect from them, and to pleaſe the eye, in ſhewing beautiful parts.

For the *draught*.—A painter muſt do it correctly, with a good taſte, well diverſified, ſometimes heroick, and ſometimes rural, according to the character of the figures he wants to introduce.

The *attitudes* are to be natural, expreſſive, varied in their actions, and contraſted in their members: they ought to be ſimple or noble, animated or moderated according to the ſubject of the picture, and the diſcretion of the painter.

Attitude, in *Painting*, is the poſture or geſture of a figure, or the diſpoſition of its parts, by which we diſcover the action it is engaged in, and the very ſentiment ſuppoſed to be in the mind of the perſon repreſented.

The *expreſſions* muſt be juſt to the ſubject; the principal figures having noble and ſublime ones; and keeping a medium between the exaggerated and inſipid.

Expreſſion, in *Painting*, denotes a natural and lively repreſentation of the ſubject, or of the ſeveral objects intended to be ſhewn. The term *expreſſion* is ordinarily confounded with that of *paſſion*; but they differ in this, that *expreſſion* is a general term, implying a repreſentation of an object, agreeable to its nature, and character, and the uſe, or office it is to have in the work; whereas *paſſion*, in *Painting*, denotes a motion of the body, accompanied with certain diſpoſitions, or airs of the face, which mark an agitation in the ſoul; ſo that every *paſſion* is an *expreſſion*, but not every *expreſſion* a *paſſion*.

The extremities, I mean the head, feet, and hands, muſt be worked with more preciſion and exactneſs than all the reſt, and muſt concur together, to render the action of the figures more expreſſive.

The *draperies* muſt be well order'd, the folds or plaits thereof large, in ſmall number, as much as poſſible, and well contraſted; the ſtuffs thick or light, *&c.* according to the quality and convenience of the figures.

Drapery, in *Painting*, is the repreſentation of the garments, or cloathing of human figures.

Animals muſt be principally characterized by an ingenious and ſpecial touch.

A *landſkip* ought not to be cut by too many objects; they ſhould be few, but well choſen; and in caſe a great quantity of objects be introduced in it, they muſt be ingeniouſly *grouped* with lights and ſhadows; the ſight well bound and free; the trees different in form, colour, and touch, as much as prudence, and the variety of nature require it; that touch ſhould be always light; the fore-parts of the landſkip rich, either by the objects, or by a greater exactneſs of work, which render the things true and palpable: the ſky is to be light, and no object on the ground ought to diſpute with its æthereal character, except ſmooth waters, and poliſhed

liſhed bodies, which are ſuſceptible of all colours oppoſed to them; of celeſtial, as well as terreſtrial ones: the clouds muſt be well choſen, well touched, and well placed.

Group, in *Painting*, is an aſſemblage or knot of two or more figures of men, beaſts, fruits, or the like, which have ſome apparent relation to each other. In a good *painting*, it is neceſſary that all the figures be divided into two or three *groups*, or ſeparate collections. Such and ſuch a thing make a *group*, with ſuch and ſuch other of different nature and kind. The antique *Laocoedon* is a fine *group* of three beautiful figures.

The *perſpective* muſt be regular, and not of ſimple practice, very little exact.

In the *coloris*, which includes two things, the *local colour*, and the *clair-obſcure*.

The *local colour* is nothing elſe but that, which is natural to each object, in what place ſoever it be found.

The *clair obſcure* is the art of diſtributing advantageouſly the lights and ſhadows, as well on the particular objects, and in the whole of the picture: on the particular objects, to give them a convenient *relievo* and roundneſs: and in the whole of the picture, that the objects may be ſeen in it with pleaſure; by giving occaſion to the ſight to reſt itſelf from ſpace to ſpace, by an ingenious diſtribution of grand *clairs*, and large ſhadows, which afford one another mutual ſuccours, by their oppoſitions; ſo that the great *clairs* are reſts for the great ſhadows; as the great ſhadows will be reſts for the great *clairs*.

In the *deſcription of colours* there muſt be an accord, which may produce the ſame effect for the eyes, as muſick does for the ears.

If there be ſeveral groups of *clair-obſcure* in a picture, one of them muſt be more ſenſible than the reſt, ſo that there may be unity of object, as in the compoſition there is unity of ſubject.

As to *the pencil*, it muſt be bold, and light, if poſſible; but whether it appears ſmooth, like that of *Correggio*, or uneven and rough, like that of *Rembrant*, it ſhould be always ſoft.

As to *licences*; if one is forced to take any, they muſt be imperceptible, judicious, advantageous, and authoriſed; the three firſt are for the art of the painter, and the laſt regards hiſtory.

The *invention*, which is an eſſential part of the art conſiſts only in finding the objects which muſt enter the picture, according to the imagination of the painter, falſe or true, fabulous or hiſtorical.

As to the *compoſition*.—Some have confounded the firſt part of *Painting* with the genius, others with a fertility of thoughts; and others with the diſpoſition of objects; but all thoſe things are different from one another. I thought that to give a clear idea of the firſt part of *Painting*, I ſhould call it *compoſition*, and divide it into two, *viz. invention* and *diſpoſition*. The *invention* finds only the objects of the *painting*; and the *diſpoſition* places them.

The *invention* is formed by reading in the ſubjects extracted from hiſtory or the fable. It is a pure effect of the imagination in *metaphorical ſubjects*; it contributes to the fidelity of the hiſtory, as to the clearneſs of the allegories; and in what manner ſoever it is uſed, it muſt never keep the mind of the ſpectator in ſuſpenſe by any obſcurity.

As to the *deſign*, which I conſider as the ſecond part of *painting*.

The qualities or conditions required in a deſign are correctneſs, good taſte, elegance, character, diverſity, expreſſion, and perſpective.

Correctneſs depends principally on the juſtneſs of the proportions, and a knowledge of anatomy. Taſte is an idea or manner of deſigning, which ariſes either from the complexion and natural diſpoſition, or from education, one's maſter, ſtudies, *&c.* Elegance gives the figures a kind of delicacy, which ſtrikes people of judgment, and a certain agreeableneſs which pleaſes every body. The character is what is peculiar to each thing; in which there muſt be a diverſity; in as much as every thing has its particular character to diſtinguiſh it. The expreſſion is, as already obſerved, the repreſentation of an object according to its character, and the ſeveral circumſtances it is ſuppoſed to be in. The perſpective is the repreſentation of the parts of a *painting* or figure, according to the ſituation they are in with reſpect to the point of ſight.

The principal rules that regard the deſign are; that novices accuſtom themſelves to copy good originals at firſt ſight; not to uſe ſquares in drawing; for fear of ſtinting and confining their judgment; to ſtay till they can deſign well after the life, before they begin the practice of perſpective rules; in deſigning after the life, to learn to adjuſt the bigneſs of their figures to the viſual angle, and the diſtance of the eye from the model or object; to mark it at all the parts of their deſign, before they begin to ſhadow; to make their contours in great pieces, without taking notice of the little muſcles, and other breaks; to make themſelves maſters of the rules of perſpective; to obſerve every ſtroke as to its perpendicular, parallel, and diſtance; and particularly ſo to compare, and oppoſe the parts that meet upon, and traverſe the perpendicular, as to form a kind of ſquare in the mind; which is the great, and almoſt the only rule of deſigning juſtly; to have a regard not only to the model, but alſo to the part already deſigned; there being

being no ſuch a thing as deſigning with ſtrict juſtneſs, but by comparing and proportioning every part to the firſt, &c.

As to *attitudes*. —— In them the ponderation and contraſt are founded in nature. It performs no action without ſhewing thoſe two parts; and was it to fail in it, it would be either deprived of motion, or conſtrained in its action.

As to *expreſſions*.—They are the touch-ſtone of the judgment of the painter: he ſhews by the juſtneſs wherewith he diſtributes them, his penetration and diſcernment.

As to the *extremities*, *viz.* the *head*, *feet*, and *hands*, muſt be more finiſhed than any other things.

As to *draperies*.—It is ſaid in *Painting*, to *throw a drapery*, or *give a drapery*, inſtead of cloathing a figure. Draperies are not to be ſet in form, as our cloaths are; but the plaits muſt be found as by chance round the members, that they may make them appear ſuch as they are; and by an induſtrious artifice, contraſt them in ſhewing them, and careſs them, as it were, by their tender ſinuoſities, and ſoftneſs.

As to the *landſkip*.——As this kind of *painting* contains an abridgement of all the others, the painter who practiſes it, muſt have an univerſal knowledge of the parts of his art, if not in ſo great a detail as thoſe who commonly paint hiſtory, at leaſt ſpeculatively, and in general. And if he does not finiſh all the objects in particular, which compoſe his piece, or accompany his landſkip, he is obliged at leaſt, to expreſs in a lively manner, the taſte and character thereof; and to give the much more ſpirit to his works, that it is leſs finiſhed.

Let a landſkip be ever ſo well finiſhed, if the compariſon of the objects does not render them valuable, and preſerve their characters, if the *ſites* be not well choſen, or are not ſupplied by a fine intelligence of the *clair-obſcure*, if the touches be not judicious, if the places be not animated by figures, animals, or other objects, which are moſt commonly in motion, and if the truth and variety of nature be not joined to the good taſte of the colour, and to the extraordinary ſenſations, the *painting* will never gain a reputation among connoiſſeurs.

As to the *perſpective*.—Some authors have imagined that perſpective and *painting* were the ſame thing, becauſe there was no *painting* without perſpective. Tho' the propoſition is falſe, abſolutely ſpeaking, ſince the body, which cannot be without ſhadow, is not, notwithſtanding, the ſame thing with the ſhadow; but however it is true, in that ſenſe, that a painter cannot do without perſpective, and that he does not draw alike, nor give a ſtroke of his pencil, without perſpective having ſome part in it, at leaſt habitually.

The colouring, in its general ſenſe, takes in whatever relates to the nature and union of colours; their agreement, or antipathy; how to uſe them to advantage in light and ſhadow, ſo as to ſhew a relievo in the figures, and a ſinking of the ground; what relates to the aerial perſpective, *i. e.* the diminution of colours by means of the interpoſition of air; the various accidents and circumſtances of the luminary and the medium; the different lights, both of the bodies illuminating and illuminated; their reflections, ſhadows, different views, with regard either to the poſition of the eye, or the object; what produces ſtrength, boldneſs, ſweetneſs, &c. in *paintings* well coloured; the various manners of colouring both in figures, landſkips, &c.

As to the *pencil*.—Here the word *pencil* ſignifies only the manner of uſing it in the application of colours; and when thoſe ſame colours have not been too much agitated, and as it is ſaid too much tormented by the motion of a heavy hand, but, on the contrary, the motion appears free, quick and light, it is ſaid that the work is of a good pencil. But that free pencil is of but little ſignification, unleſs it be guided by the head, and ſhew that the painter is maſter of his art. In a word, a fine pencil is to *painting* what muſick is to a fine voice; ſince both are eſteemed in proportion of the grand effect, and harmony which accompany them.

The next thing our pupil painter is to provide himſelf with, is all ſorts of colours, the principal thereof are *red*, and *white lead*, or *ceruſs*, *yellow okers*, ſeveral kinds of earth, as *umber*, &c. beſides *orpiment*, *black lead*, *cinnabar*, *gumboach*, *lake*, *bice*, *verditer*, *indigo*, *vermillion*, *verdigreaſe*, *ivory black*, *lampblack*, *ſmalt*, *ultramarine*, *Pruſſian blue*, and *carmine*.

Ceruſs makes a beautiful white colour, and is much uſed both in oil and water-colours. The beſt *ceruſs* is that of *Venice*; but this is rare, that chiefly uſed is either *Engliſh* or *Dutch*, both of which have more marl in them than white lead; the latter however is the better of the two.—*Orpiment* muſt be choſen of a golden yellow hue, eaſy to ſcale, and the ſcales very thin, ſmall and ſhining like gold.—The *umber* or *umbre*, is a dry duſky coloured earth, which diluted with water, ſerves to make a dark brown colour, uſually called with us a hair-colour. It is called *umber* from *umbra*, ſhadow; as ſerving chiefly for the ſhadowing of objects; or rather from *Umbria*, a province of *Italy*, whence it is uſed to be brought. The beſt *oker* is that of *Berry* in *France*.—*Verditer* is uſed for a blue, but moſt uſually is mixed with yellow for a green colour.——The *vermillion* is a bright beautiful red colour. We have two kinds of it

from *Holland*; the one of a deep red, the other pale: but it is of the ſame matter at bottom, the difference of colour only, proceeding from the cinnabar's being more or leſs ground; when fine ground the vermillion is pale, and this is preferred to the coarſer and redder.—The *verdigreaſe*, to be good, muſt be very dry, of a deep green, and pretty clear of white ſpots.—The *ultramarine* is a beautiful blue colour, prepared from *lapis lazuli*. This blue is one of the richeſt and moſt valuable colours uſed in *painting*.—The preparation conſiſts in firſt calcining the *lapis* in an iron pot or crucible, then grinding it very fine on a porphyry ſtone, then mixing it up with a paſte made of wax, pitch, maſtick, turpentine, and oil; and at laſt waſhing the paſte well in clear water, to ſeparate the colouring part from the reſt, which precipitates to the bottom in form of a ſubtile, beautiful blue powder. The water is then poured off, and the powder at bottom dried in the ſun; which is the true *ultramarine*. Thoſe who prepare this colour have uſually four kinds, which they procure by ſo many different lotions: the firſt is ſtill the beſt, and the reſt worſe and worſe to the laſt. *Ultramarine* muſt be choſen of a high colour, and well ground, which is known by putting it between the teeth, where, if it feels gritty, it is a ſign the triture is not ſufficient. To know whether it be pure or unmixed, put a little of it in a crucible, and heating it red-hot, if the powder has not changed its colour after this trial, it is certainly pure: on the contrary, if you perceive any change, or any black ſpecks in it, it is falſified. Beſides this, there is another called *common* or *Dutch ultramarine*; which is only *lapis* or *ſmalt* well ground and pulverized, the colour whereof when uſed by the painters is much like that of true *ultramarine*, though much leſs valued. This is alſo called *Pruſſian blue*.——*Carmine* is a bright red or crimſon colour, bordering ſomewhat on purple, uſed by painters in miniature, and ſometimes by painters in oil, though rarely, by reaſon of its exceſſive price. To be good, it muſt be almoſt an impalpable powder. Thoſe that ſell it mix it with a ſmall quantity of red lead, in proportion to the quantity of *carmine*, to make it weigh heavy, which is a very great piece of knavery.

Painters reduce all theſe colours above-mentioned, and the other they uſe under two claſſes, *viz. dark* and *light colours*. Under *light colours* are comprehended white, and all thoſe which approach neareſt it.—And under *dark colours*, black, and all thoſe which are obſcure and earthy, as umber, biſtre, &c.

Simple and *mineral colours*, is another diviſion among them. Under *ſimple colours* they range all thoſe uſed by limners, illuminers, &c. extracted from vegetables; and which will not bear the fire: as the yellow made of ſaffron, of *French* berries, &c. Lacco, and other tinctures extracted from flowers. The reſt are *mineral*, drawn from metals, &c. and are to bear the fire.

Our next care is to find a *porphyry*, to grind and mix *colours* and *pencils*, *bruſhes*, &c. to apply them.

There are *pencils* of various kinds, and more of various matters; the moſt uſeful are made of badgers and ſquirrels hair, thoſe of ſwans down, and thoſe of boars briſtles; which laſt are bound on to a ſtick, bigger or leſs, according to the uſes they are deſtined for; and when large are called *bruſhes*. The others are incloſed in the barrel of a quill.

Beſides *pencils*, we muſt have a *pallet*, which is a little oval table, or piece of wood or ivory, very thin and ſmooth; on and round which the painters place the ſeveral colours they have occaſion for, ready for the pencil. The middle ſerves to mix the colours on, and to make the teints required in the work. It has no handle, but in lieu thereof, a hole at one end, to put the thumb through to hold it.

Colours are prepared in three different manners, either with ſize, whites of eggs, &c. or with water, or with oil.

The working of *colours* with ſize or white of eggs, is ſaid done in *diſtemper*, which was the uſual manner of mixing *colours*, before the beautiful ſecret was found of mixing them with oil.

Colours diluted with water, are called *water-colours*; which is done by melting a proper quantity of gum-arabick, in water, and diluting the *colours* in that water.——*Colours* thus prepared are moſt commonly uſed in *painting* in miniature, and limning.

Oil-colours are ground on the porphyry or marble, by means of a moler or muller. In this preparation, care muſt be taken, that they be ground fine; that in putting them on the pallet, thoſe which will not dry of themſelves, be mixed with oil, or other dryers; and that the tinged colours be mixed in as ſmall quantities as poſſible.

Our *colours* thus prepared, I'll return to *painting*, which, with regard to the materials, the matter whereon they are applied, and the manner of applying them, is of various kinds, hence came *painting* in freſco; *painting* in oil; *painting* in water-colours, or limning; *painting* in miniature; *painting* in enamel; and *painting* on glaſs.

Freſco is a kind of *painting* performed on a freſh plaiſter, or on a wall laid with mortar, not yet dry, and with water-colours.

The colours uſed, are white made of lime ſlaked long ago, and white marble duſt; oker, both red

an

and yellow; violet red; verditer; lapis lazuli; ſmalt; black earth, &c. all which are only ground and worked up with water; and moſt of them grow brighter and brighter, as the *freſco* dries.

This ſort of *painting* is chiefly performed on walls and vaults, newly plaiſter'd with lime and ſand: but the plaiſter is only to be laid in proportion as the *painting* goes on; no more being to be done at once than the painter can diſpatch in a day, while it is dry.

Before he begins to paint, a cartoon or deſign is uſually made on paper, to be calked and transferred to the wall, about half an hour after the plaiſter is applied.

Painting in oil is performed on walls, on wood, canvas, ſtones, and all ſorts of metals.

To paint on a wall.—When well dry, you muſt give it two or three waſhes with boiling oil, till the plaiſter remains quite greaſy and will imbibe no more. Over this are applied deſiccative or drying colours, *viz.* white chalk, red oker, or other chalks beaten pretty ſtiff. This layer being well dryed, you'll ſketch and deſign your ſubject; and at laſt paint it over; mixing a little varniſh with your colours, to ſave the varniſhing afterwards.

Others to fortify their wall better againſt moiſture, cover it with a plaiſter of lime, marble duſt, or a cement made of beaten tiles ſoaked with linſeed-oil; and at laſt prepare a compoſition of *Greek* pitch, maſtich, and thick varniſh, boiled together, which they apply hot over the former plaiſter; when dry, the colours are applied as before.

To paint on wood.—They uſually give their ground a layer of white, temper'd with ſize; or they apply the oil above-mentioned. The reſt as in *painting* on walls.

To paint on cloth or canvas.—The canvas being ſtretched on a frame, you muſt give it a layer of ſize, or paſte-water. When dry you ſhall go over with a pumice-ſtone, to ſmooth off the knots.

When the cloth is dry, a lay of oker muſt be laid on, ſometimes mixing with it a little white lead to make it dry the ſooner. When dry you'll go again over it with the pumice ſtone, to make it ſmooth.

After this, a ſecond layer, compoſed of white lead, and a little charcoal black is ſometimes added, to render the ground of an aſh-colour; obſerving in each manner to lay on as little colour as poſſible.

As little oil is to be uſed as poſſible, if it be deſired to have the colours keep freſh: for this reaſon, ſome mix them with oil of aſpick, which evaporates immediately, yet ſerves to make them manageable with the pencil.

As to oils, the beſt are thoſe of walnuts, linſeed, aſpick, and turpentine. The deſiccative or drying oils, are a nut oil boiled with litharge, and ſandarach; others with ſpirit of wine, maſtic, and gum-lacca.

The next operation is to draw the deſign on the canvas; and afterwards to prime the work, which is done by laying a lay of white all over it, except on the lines of the draught, which muſt be kept viſible. Then if the picture be a hiſtory-piece, or a portrait, the painter begins by the face or faces; which together with all the other naked parts to be pronounced in the picture, are called *carnations*. The *carnations* are made with white and carmine; and brown, blue, and yellow for the ſhadows; according to the complexion the painter deſigns to give to the figure or figures he is to repreſent.

The application of colours, in *painting*, is conſider'd either with regard to the kinds of *painting*, in works of various colours, or in thoſe of one ſingle colour.

Firſt, in the larger pieces, the colours are rather laid on full, ſo as they may be impaſſed or incorporated together, which make them hold the more firmly.

Or elſe the more agreeable ones, which dry too hard and too haſtily, are mixed with a little colour, and the cleareſt of the oil. But in both caſes, the colours are to be laid on ſtrong at firſt; it being eaſy to weaken thoſe which are to be thruſt back, and to heighten the others: the touches to be bold, by the conduct of a free and ſteady pencil; that the work may appear the moſt finiſhed at a proper diſtance, and the figures animated with life and ſpirit.

For *glazed colours*, care muſt be taken, that the under-colour be painted ſtrong, and that it be a body colour, and laid ſmooth.

In finiſhed works, which are to be viewed near at hand, the proceſs is either by applying each colour in its place; preſerving their purity, without fretting or tormenting them, but ſweetly ſoftening off their extremities; or by filling up all the great parts with one ſingle colour; and laying the other colours which are to form the little things, upon it. Which is the more expeditious way, but more apt to decay.

For the ſecond; the kinds of pictures in one colour are two, *viz. Camieux*, where the degradations of colours of objects afar off, are uſually managed by lights, or with crayons, and baſs relievo, which is an imitation of ſculpture, of whatſoever matter and colour; in both theſe the colours are wrought dry.

For the *œconomy*, and diſpenſing of colours in *paintings*, regard is either had, firſt, to the qualities

of the colours, to appropriate them according to their value and agreement: or, ſecondly, to their effect, in the union and œconomy of the work.

For the *qualities*, it muſt be obſerved, that white repreſents light, and gives the briſkneſs and heightening; black, on the contrary, like darkneſs, obſcures and effaces the objects: again, black ſets off the light parts, and by that they ſerve each other to looſen the objects. A proper choice to be made of colours; and the too much charged manner to be avoided; both in carnations, where red colours are not to be affected, or rather reſembling the fleſh when ſtead than the ſkin; and all bright glowing colours; the ſkin, how delicate ſoever, being always of a bloom colour. In the drapery, where the painter has his whole ſtock of colours to chuſe out of to procure a good effect; and in the landſkip, to diſpoſe thoſe colours near one another, which mutually aſſiſt and raiſe each other's force and briſkneſs; as red and green, yellow and blue.

To manage them ſo, as that they may be accommodated to the effects of the great parts of light and colours; that the ſtrong colours lead to the ſoft ones, and make them more look'd at, bringing them forwards, or keeping them back, according to the ſituation and the degree of force required.

For the *effects of colours*, they either regard the union, or the œconomy; with reſpect to the firſt, care muſt be taken that they be laid ſo as to be ſweetly united, under the briſkneſs of ſome principal one; that they participate of the prevailing light of ths piece, and that they partake of each other by the communication of light, and the help of reflection.

For the *œconomy in managing their degrees*, regard is to be had to the contraſt, or the oppoſition intervening in the union of the colours, that by a ſweet interruption the briſkneſs which otherwiſe fades and palls, may be raiſed: to the harmony, which makes the variety of colours agree, ſupplying and ſuſtaining the weakneſs of ſome by the ſtrength of others, neglecting ſome places on purpoſe to ſerve as a baſis or repoſe to the ſight, and to inhance thoſe which are to prevail through the piece: to the degradation, where the better to proportion the colours that fall behind, ſome of the ſame kind are to be preſerved in their purity, as a ſtandard, for thoſe carried afar off to be compared by, in order to juſtify the diminution: regard being always had to the quality of the air, which, when loaded with vapours, weakens the colours more than when clear: to the ſituation of the colours, where care muſt be taken, that the pureſt and the ſtrongeſt be placed before, or in the front of the piece; and that by their force, the compound ones, which are to appear at a diſtance, be kept back, particularly the glazed colours to be uſed in the firſt rank. Laſtly, to the expreſſion of the ſubject, and the nature of the matters, or ſtuffs, whether ſhining or dull, opake or tranſparent, poliſhed or rough.

The different colours, which you are to employ in your picture are to be mixed as follows. For a violet colour, take indigo, white lead and lake; mix them all well together; and the more or leſs of each quantity will make it deeper or lighter. A lead colour is made of white and indigo, well mixed together. A ſcarlet of lake, red lead, and a little vermilion. Though, in fine *paintings*, I would prefer carmine, with a very ſmall quantity of ultramine, and a ſtill ſmaller one of fine *ceruſs*. A light green of pink and ſmalt. A middle and light green, of verdigreaſe and pink; a deep and ſad green, indigo and pink. A purple colour of *Spaniſh* brown, indigo and white, well mixed. A murrey colour of white and lake. A flame colour, of red lead and maſticot, heightened with white. But theſe general rules are not to captivate the imagination of a painter, no more than the following ones; for a good painter, who has a good natural genius for his art, and takes pleaſure in the practice thereof, makes often new diſcoveries, to render his draperies more beautiful; as for carnations they are always made of the ſame mixture of colours; the whole ſecret conſiſting in the judicious application thereof.

After a painter has transferred his draught on his canvas, and has primed it, he begging his piece, firſt, by drawing the eyes (having while he works, his right hand ſupported with a moll-ſtick or ſtay, made of heavy wood, not ſubject to bend, about a yard long, having at the end, which leans againſt the picture, a ball of ravell'd cotton, with a leather over it, the other end held with the left-hand) making the white thereof with white lead, with a little charcoal black. This finiſhed, he leaves from the other eye (in a face full front) the diſtance of an eye, then draws the proportion of the noſe; afterwards makes the mouth, ears, &c. This done, he lays his carnation or fleſh-colour over the face, caſting in, here and there ſome ſhadows, which he works in by degrees with the fleſh colour: which fleſh-colour is commonly compounded of white lead, lake, and vermilion or carmine, this laſt being beſt. There is no fixed rule for heightening or deepening this colour; for it is left to the diſcretion and judgment of the painter; who muſt conſult in this his own imagination, with regard to the age, country, &c. of the perſon, whoſe face he endeavours to repreſent. Then he ſhadows the face over as he ſees cauſe, and finiſhes the noſe, compaſſing the tip of it,

with ſome dark, or light reddiſh ſhadow; which ſhadows, for the face, are commonly compounded of ivory black, white-lead, vermilion, lake, ſeacoal black, &c. The cheeks and lips are ſhadowed with vermilion or carmine, and lake mixed together; and the mouth ſtroke is made with lake only. As to the circles of the eyes; for grey eyes they are made of charcoal black and white lead, heighten'd and deepen'd at pleaſure: the black circle of the eye is made of umber, ſeacoal black, and a little white mixed together: the round ball in the eye of lamp-black and verdigreaſe, ſince the lamp-black will hardly dry without it. The ſame colours uſed in *painting* and ſhadowing the face, are uſed in *painting* the hands, and ſhadowing them between the fingers. When a painter wants to make a fleſh-colour of a ſwarthy complection, he mixes white-lead, lake, and yellow oker together, and ſhadows it with a mixture of umber and ſeacoal black.

For black hairs he uſes lamp-black only, and when he will have them brighter, mixes it with a little umber, white and red-lead. For flaxen hairs he takes umber and white-lead; putting in more umber if he wants them browner, and more white-lead, if whiter; but if quite dark, he adds a little ſeacoal black. Yellow hairs are made of a mixture of maſticot, umber, yellow oker, and a little red-lead; increaſing the quantity of umber and red-lead, if they be wanted redder. For white hairs he takes an equal quantity of ivory black, and of umber, *viz.* half of each, and tempers them well upon his pallet with white lead, taking more or leſs of thoſe three colours, according as the hairs are to be heighten'd or deepen'd.

The teeth are made of white-lead, and ſhadowed with charcoal-black.

As to the different ſtuffs the figures are to be cloathed with, it muſt be left entirely to the imagination and judgment of the painter.

The ſeveral colours uſed in *painting*, are alſo called *teints*, and *ſemi-teints*; conſidering the colours as more or leſs high, or bright, or deep, or thin, or weakened and diminiſhed, &c. to give the proper relievo, or ſoftneſs, or diſtance, &c. to the ſeveral objects; and the leſſening and rendering dim and confuſed the appearance of different objects in a landſkip, ſo as they ſhall appear there as they would do to an eye placed at that diſtance from them, is called, in painting, *degradation*.

As to *painting* in WATER-COLOURS, called *limning*, in contradiſtinction of *painting* properly ſo called, which is done in oil colours, the uſual colours are proper enough, excepting the white, made of lime, which is only uſed in freſco. But the azure, or ultramarine, muſt always be mixed up with ſize, or with gum, in regard the yolks of eggs give blue colours a greeniſh tincture; but there are always applied two lays of hot ſize, ere the colours mixed even with ſize, are laid on: the compoſition made with eggs, and the juice of the fig-tree, being only uſed for touching up, and finiſhing, and to prevent the neceſſity of having the fire always at hand to keep the ſize hot; yet it is certain, that the ſize colours hold the beſt, and are accordingly always uſed in cartoons, &c.—This ſize is made of ſhreds of thin leather, or of parchment.

To limn on linen, the beſt is that which is old, half worn and cloſe.—This is ſtamped with white lead, or a fine plaiſter beaten up with ſize; which once dry, we muſt go over it with a layer of the ſame ſize,

The colours are all ground in water, each by itſelf; and in proportion as they are required in working, are diluted with their ſize-water. — If the yolks of eggs are deſired, they muſt be diluted with water made of equal quantity of common water and vinegar, with the yolk, white, and ſhell of an egg, and the end of the little branches of a fig-tree cut ſmall, all well beaten together in an earthen pan.

Painting in MINIATURE is a delicate kind of *painting*, conſiſting of little points or dots inſtead of lines, uſually done on vellum, with very thin ſimple water-colours.

The colours for *miniature* may be mixed up with water of gum-arabick, or gum tragacanth.

The operation is uſually made on vellum, on which the deſign is drawn, with carmine, or ſome other colour, which may render the lines diſcernable. That draught is filled afterwards, with a very thin and ſmooth lay of white, though ſome chuſe to paint on the naked vellum without any lay; though in my opinion it contributes much towards incorporating well the colours, that the dots may not appear ſo viſible, and ſo coarſe, as they do without it. When the lay is dry, the painter ſearches with his pencil all the lines of the draught, leſt ſome of them ſhould be either much weakened, or entirely obliterated by the lay of white; then he begins, as in all other paintings, by the face, dipping firſt the point of his pencil in water, and rubbing it afterwards, on the colour he deſigns to employ; when thus rubbed, he makes the point thereof with the tip of his lips, and then apply it on the vellum, repeating the ſame proceſs every time he wants colours, and having different pencils for the different colours. He has alſo before him a ſhell with gum-water, in caſe he wants

wants to dip his pencil in it, as it often happens.

Painting in moſaick is an aſſemblage of little pieces of glaſs, marble, ſhells, precious ſtones, woods, or the like of various colours cut ſquare, and cemented on a ground of ſtucco, imitating the natural colours and degradations of *painting*.

PAPER-MAKING.

PAPER-MAKING is the art of preparing certain materials, on which mankind have, in different ages, contrived to write their ſentiments.

PAPER, with regard to the *manner* of making it, and the *materials* employed therein, is reducible to ſeveral kinds; as *egyptian* paper, made of the ruſh *papyrus*; *bark* paper, made of the inner rind of ſeveral trees; *cotton* paper; *incombuſtible* paper; and *European* paper, made of linen rags.

Egyptian paper was principally uſed among the antients; being made of the *papyrus*, or *biblus*, a ſpecies of ruſh, which grew on the banks of the *Nile*; in making it into paper, they began with lopping off the two extremes of the plant, the head and the root; the remaining part, which was the ſtem, they cut lengthwiſe into two nearly equal parts, and from each of theſe they ſtripped the ſcaly pellicles of theſe which it conſiſted. The innermoſt of theſe pellicles were looked on as the beſt, and that neareſt the rind as the worſt: they were therefore kept apart, and made to conſtitute two different ſorts of paper. As the pellicles were taken off, they extended them on a table, laying them over each other tranſverſely, ſo as that the fibres made right angles; in this ſtate they were glued together by the muddy waters of the *Nile*, or, when thoſe were not to be had, with paſte made of the fineſt wheat-flour, mixed with hot water and a ſprinkling of vinegar. The pellicles were next preſſed, to get out the water, then dried, and laſtly, flatted and ſmoothed by beating them with a mallet. This was the *Egyptian* paper, which was ſometimes farther poliſhed, by rubbing it with a glaſs ball, or the like.

Bark-paper was only the inner whitiſh rind, incloſed between the bark and the wood of ſeveral trees, as the maple, plane, beech, and elm, but eſpecially the *tilia*, or *linden tree*, which was that moſtly uſed for this purpoſe. On this, ſtripped off, flatted, and dried, the antients wrote books.

Chineſe-paper is of various kinds; ſome is made of the rinds or barks of trees, eſpecially the *mulberry-tree* and *elm*, but chiefly of the *bambu* and *cotton-tree*. In fact, almoſt each province has its ſeveral paper. The preparations of paper made of the barks of trees, may be inſtanced in that of the *bambu*, which is a tree of the cane or reed-kind. The ſecond ſkin of the bark, which is ſoft and white, is ordinarily made uſe of for paper: this is beat in fair water to a pulp, which they take up in large moulds, ſo that ſome ſheets are above twelve feet in length: they are completed, by dipping them, ſheet by ſheet, in alum-water, which ſerves inſtead of the ſize among us, and not only hinders the paper from imbibing the ink, but makes it look as if varniſhed over. This paper is white, ſoft, and cloſe, without the leaſt roughneſs: tho' it cracks more eaſily than *European* paper, is very ſubject to be eaten by the worms, and its thinneſs makes it liable to be ſoon worn out.

Cotton-paper is a ſort of paper, which has been in uſe upwards of ſix hundred years. In the *French* king's library are manuſcripts on this paper, which appear to be of the Xth century; and from the XIIth century, cotton manuſcripts are more frequent than parchment ones. *Cotton-paper* is ſtill made in the *Eaſt-Indies*, by beating cotton-rags to a pulp.

Linen, or *European* paper appears to have been firſt introduced among us towards the beginning of the XIVth century; but by whom this valuable commodity was invented, is not known.

The method of making paper of linen or hempen rags, is as follows: the linen-rags being carried to the mill, are firſt ſorted; then waſhed very clean in puncheons, whoſe ſides are grated with ſtrong wires, and the bottoms bored full of holes. After this they are fermented, by laying them in heaps, cloſe covered with ſacking, till they ſweat and rot; which is commonly done in four or five days. When duly fermented, they are twiſted into handfuls, cut ſmall, and thrown into oval mortars, made of well ſeaſoned oak, about half a yard deep, with an iron-plate at bottom, an inch thick, eight inches broad, and thirty long: in the middle is a waſhing-block, grooved with five holes in it, and a piece of hair-ſieve faſtened on the inſide: this keeps the hammers from touching it, and prevents any thing going out except the foul water.

Theſe mortars are continually ſupplied with water, by little troughs, from a ciſtern, fed by buckets fixed to the ſeveral floats of a great wheel, which raiſes the wooden hammers, for pounding the rags in the mortars.

When

When the rags are beaten to a certain degree, called the firſt ſtuff, the pulp is removed into boxes, made like corn-chandlers bins, with the bottom board aſlant, and a little ſeparation on the front, for the water to drain away.

The pulp of the rags being in, they take away as many of the front-boards as are needful, and preſs the maſs down hard with their hands; the next day they put on another board, and add more pulp, till the box is full: and here it remains mellowing a week, more or leſs, according to the weather.

After this, the ſtuff is again put into clean mortars, and is beaten a-freſh, and removed into boxes, as before; in which ſtate it is called the ſecond ſtuff.

The maſs is beat a third time, till ſome of it being mixed with fair water, and brewed to and fro, appears like flour and water, without any lumps in it: it is then fit for the pit-mortar, where it is perfectly diſſolved, and is then carried to the vat, to be formed into ſheets of paper.

But lately, inſtead of pounding the rags to a pulp with large hammers, as above, they make uſe of an engine, which performs the work in much leſs time. This engine conſiſts of a round ſolid piece of wood, into which are faſtened ſeveral long pieces of ſteel, ground very ſharp. This is placed in a large trough with the rags, and a ſufficient quantity of water. At the bottom of the trough is a plate with ſteel bars, ground ſharp like the former; and the engine being carried round with prodigious velocity, reduces the rags to a pulp in a very ſhort time.

It muſt be obſerved, that the motion of the engine cauſes the water in the trough to circulate, and by that means conſtantly returns the ſtuff to the engine. The trough is conſtantly fed with clean water at one end, while the dirty water from the rags is carried off at the other, thro' a hole, defended with wire-gratings, in order to hinder the pulp from going off with the dirty water.

When the ſtuff is ſufficiently prepared as above, it is carried to the vat, and mixed with a proper quantity of water, which they call priming the vat. The vat is rightly primed, when the liquor has ſuch a proportion of the pulp, as that the mould, on being dipped into it, will juſt take up enough to make a ſheet of paper, of the thickneſs required.

The mould is a kind of ſieve, exactly of the ſize of the paper to be made, and about an inch deep, the bottom being formed of fine braſs-wire, guarded underneath with ſticks, to prevent its bagging down, and to keep it horizontal; and further, to ſtrengthen the bottom, there are large wires placed in parallel lines, at equal diſtances, which form thoſe lines viſible in all white paper, when held up to the light: the mark of the paper is alſo made in this bottom, by interweaving a large wire in any particular form.

This mould the maker dips into the liquor, and gives it a ſhake as he takes it out, to clear the water from the pulp. He then ſlides it along a groove to the coucher, who turns out the ſheet upon a felt, laid on a plank, and lays another felt on it; and returns the mould to the maker, who by this time has prepared a ſecond ſheet, in another mould: and thus they proceed, laying alternately a ſheet and a felt, till they have made ſix quires of paper, which is called a poſt; and this they do with ſuch ſwiftneſs, that, in many ſorts of paper, two men make twenty poſts, or more, in a day.

A poſt of paper being made, either the maker or coucher whiſtles; on which four or five men advance, one of whom draws it under the preſs, and the reſt preſs it with great force, till all the water is ſqueezed from it; after which it is ſeparated, ſheet by ſheet, from the felts, and laid regularly one ſheet upon another; and having undergone a ſecond preſſing, it is hung up to dry.

When ſufficiently dried, it is taken off the lines, rubbed ſmooth with the hands, and laid by till ſized, which is the next operation. For this they chooſe a fine temperate day, and having boiled a proper quantity of clean parchment or vellum-ſhavings, in water, till it comes to a ſize; they prepare a fine cloth, on which they ſtrew a due proportion of white vitriol and roch-alum, finely powdered, and ſtrain the ſize through it, into a large tub; in which they dip as much paper at once as they can conveniently hold, and with a quick motion give every ſheet its ſhare of the ſize, which muſt be as hot as the hand can well bear it.

After this the paper is preſſed, hung up ſheet by ſheet to dry; and being taken down, is ſorted, and what is only fit for outſide quires, laid by themſelves: it is then told into quires which are folded and preſſed. The broken ſheets are commonly put together, and two of the worſt quires are placed on the outſide of every ream or bundle; and being tied up in wrappers, made of the ſettling of the vat, it is fit for ſale.

Paper is of various kinds, and uſed for various purpoſes: with regard to colour, it is principally diſtinguiſhed into *white*, *blue*, and *brown*; and with regard to its dimenſions, into *atlas*, *elephant*, *imperial*, *ſuper-royal*, *royal*, *medium*, *demy*, *crown*, *fool's cap*, and *pot-paper*.

As Engliſh paper is, in general, as good as any we receive from abroad, a very high duty is laid on the importation of all foreign paper, which is more

or leſs, according to the ſize, the value, and the country from whence it is brought; thus royal atlas fine, and fine imperial paper, pay 1 *l.* 9 *s.* 8 ¼ *d.* the ream; fine *Genoa* and *Dutch* royal pay 17 *s.* 8¼ *d.* the ream; *Genoa* and *German* crown and fool's cap paper pay about 2 *s.* 7 *d.* and *Genoa* pot pays 2 *s.* 2 ½ *d.* and for every 20 *s.* value, according to the book of rates, of paper brought from *Rochelle*, 6 *s.* No drawback is allowed on foreign paper exported.

As to the *incombuſtible paper*, it is made of *lapis aſbeſtos*, or the *linum vivum*, which will bear burning without being injured.

The manner of making this extraordinary *paper* is deſcribed by Mr. *Lloyd* from an aſſay made by himſelf. He pounded a quantity of *aſbeſtos* in a ſtone mortar, till it became of a downy ſubſtance; then ſifted it thro' a fine ſeirce, and by this means purged it indifferently well from its terrene parts; for what earth or ſtones he could not pick out of it before, or at the pounding, being reduced to a powder, came through the ſeirce, the linum remaining. This done, he brought it to the paper-mill, and putting it in water in a veſſel juſt big enough to make a ſheet with ſuch a quantity, he ſtirred it pretty much, and deſired the workmen to proceed with it in the uſual method, with their writing-paper mould; only to ſtir it about always before they put their mould in; conſidering it as a far more ponderous ſubſtance than what they uſed, and that frequently, if not immediately taken up after it was agitated, it would ſubſide.

The *paper* made of it proved but coarſe, and too apt to tear; but this being the firſt trial, there is reaſon to believe it might be much improved.

Beſides our *modern paper*, made of linen rags, we write likewiſe on ſkins of ſheep or goats, prepared after a particular manner, and which we call *parchment* or *vellum*.

Parchment is begun by the ſkinner, and ended by the *parchment-maker*.

After the ſkin has been ſtripped of its wool, and paſſed the lime-pit, the ſkinner ſtretches it on a kind of frame, conſiſting of four pieces of wood, morticed into each other at the four angles, and perforated lengthwiſe from diſtance to diſtance, with holes, furniſhed with wooden pins, that may be turned at pleaſure like thoſe of a violin.

To ſtretch the ſkin on this frame, they make little holes all around it, and through every two holes draw a little ſkewer; to this ſkewer they tie a piece of ſmall pack-thread, and tie that over the pins; ſo that coming to turn the pins equally, the ſkin is ſtrained tight every way, like that of a drum.

The ſkin being thus ſufficiently ſtretched on the frame, the fleſh is pared off with a ſharp inſtrument for that purpoſe. This done, it is moiſten'd with a rag, and a kind of white ſtone or chalk, reduced to a find duſt, ſtrewed over it; then with a large pumice-ſtone, flat at bottom, much after the manner of a mullet for grinding colours, they rub over the ſkin, as if about to grind the chalk; and thus ſcour off the remains off the fleſh. They then go over it again with the iron inſtrument; again moiſten it as before, and again rub it with the pumice-ſtone, without any chalk underneath; this ſmoothens and ſoftens the fleſh-ſide very conſiderably. They drain it again, by paſſing over it the iron-inſtrument as before.

The fleſh-ſide thus drained, they paſs the iron on the wooll or hair-ſide; then ſtretch it tight on the frame by means of the pins, and go over the fleſh-ſide again with the iron; this finiſhes its draining, and the more the ſkin is drained, the whiter it ever becomes.

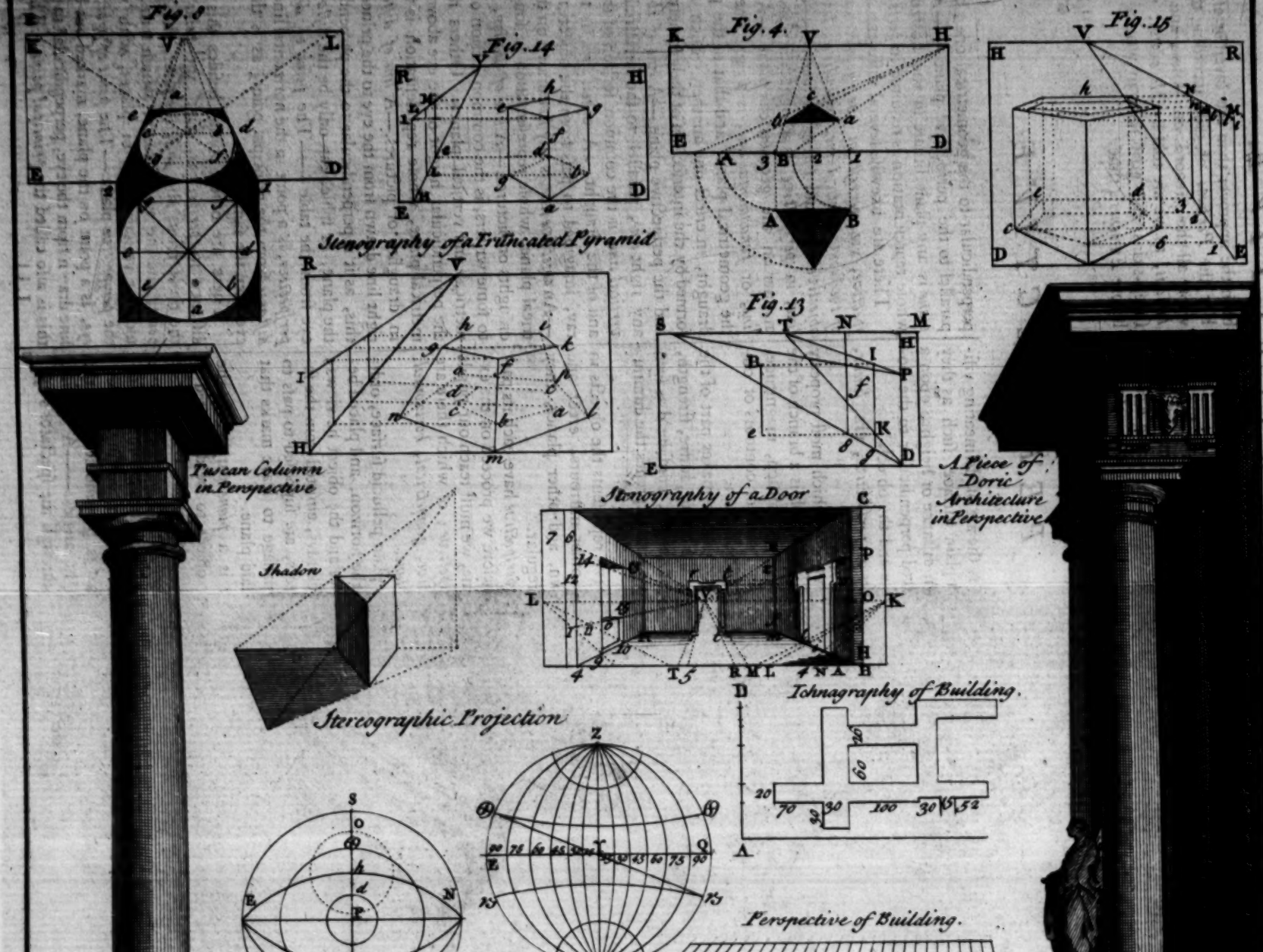
They now throw on more chalk, ſweeping it over with a piece of lamb-ſkin, that has the wool on; this ſmoothens it ſtill farther, and gives it a white down or nap. It is now left to dry, and when dried, taken off the frame by cutting it all round.

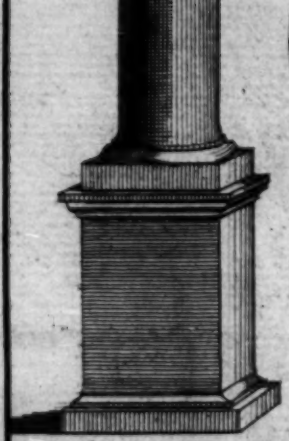
The ſkin, thus far prepared by the *ſkinner*, is taken out of his hand by the *parchment-maker*, who firſt ſcrapes or pares it dry on the ſummer, with an iron inſtrument like that above-mentioned, only finer and ſharper; with this, worked with the arm from top to bottom of the ſkin, he takes away about one half of its thickneſs. The ſkin thus equally pared on both ſides, they paſs the pumice-ſtone over both ſides to ſmooth it. This laſt preparation is performed on a kind of form or bench covered with a ſack ſtuffed with flocks, and leaves the *parchment* in a condition for writing on.

The paring the ſkin dry on the ſummer, is the moſt difficult operation in the proceſs of *parchment-making*; for which reaſon the *ſkinners* ſeldom meddle with it, but uſually leave it to thoſe more experienced in it: the ſummer whereon it is perform'd is a calf-ſkin well ſtretched on a frame, ſerving as a ſupport to the ſkin, which is faſtened a-top of it with a wooden inſtrument that has a notch cut in it. Laſtly, that the iron kniſe may paſs the eaſier between the ſummer and the ſkin to be pared, they put another ſkin which they call the counter-ſummer. The parings thus taken off the leather, are uſed in making glue, ſize, *&c.*

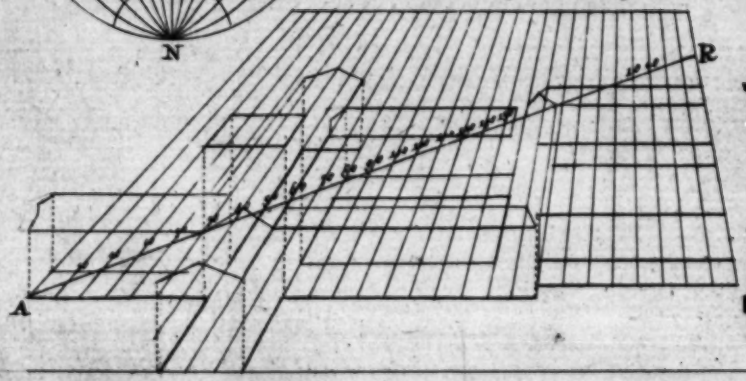
What we call *vellum*, is only *parchment* made of the ſkin of abortive calves, or at leaſt of ſucking calves, 'tis finer, whiter, and ſmoother than the common *parchment*, but it is prepared in the ſame manner,

PERSPECTIVE.

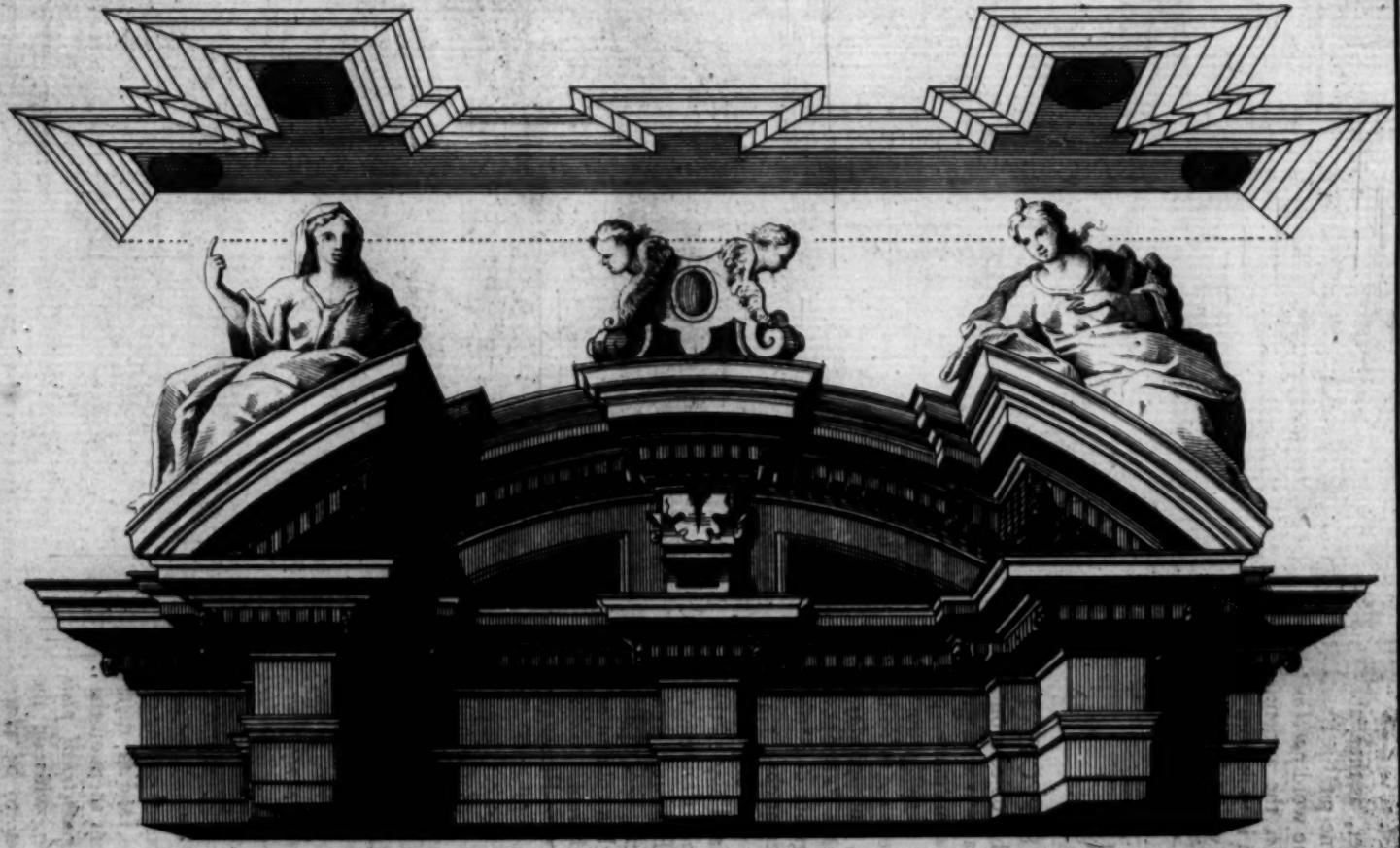




Perspective of Building.



Line of Distance



Composite Cornice in Perspective.

manner, as that, abating that it is not paſſed thro' the lime-pit.

The word *parchment* comes from the *Latin pergamena*, the antient name of this manufacture; which it took from the city *Pergamos*, to *Eumenes*, king whereof, its invention is uſually aſcribed. Though in reality that prince appears rather to have been the improver than the inventer of *parchment*. For the *Perſians* of old, according to *Diodorus*, wrote all their records on skins; and the antient *Ionians*, as we are told by *Herodotus*, made uſe of ſheep-skins and goat-skins in writing many ages before *Eumenes*'s time.

PERSPECTIVE.

PERSPECTIVE is the art of delineating viſible objects on a plain ſurface, ſuch as they appear at a given diſtance or height, upon a tranſparent plane, placed perpendicular to the horizon, between the eye and the object.

There are three ſorts of *perſpective*, viz. *linear*, *aerial*, and *ſpecular perſpective*.

Linear PERSPECTIVE (to which moſt properly belongs our definition, and which is a branch of the Mathematicks) regards the poſition, magnitude, form, *&c.* of the ſeveral lines or contours of objects, and expreſs their diminution.

Aerial PERSPECTIVE (which makes part of the art of Painting) regards the colour, luſtre, ſtrength, boldneſs, *&c.* of diſtant objects, conſider'd as ſeen through a column of air, and expreſſes the diminutions thereof.

Specular PERSPECTIVE repreſents the objects in conical, ſpherical, or other mirrours, erect and clear; whereas on lawn, and other planes, they appear confuſed and irregular.

Theſe three ſorts of *perſpective* have each its particular doctrine; but before we proceed on the explanation of that doctrine, we muſt teach our pupils what are *planes* in *perſpective*; of which there are five ſorts, viz. *perſpective*, *geometrical*, *horizontal*, *vertical*, and *objective plane*.

Perſpective plane is a plain pellucid ſurface, ordinarily perpendicular to the horizon, and placed between the ſpectator's eye and the object he views; through which the optick rays, emitted from the ſeveral points of the objects, are ſuppoſed to paſs to the eye, and in their paſſage to leave marks that repreſent them on the ſaid plane.

A *geometrical plane* is a *plane* parallel to the horizon, whereon the object to be delineated is ſuppoſed to be placed: this *plane* is uſually at right angles with the *perſpective plane*.——A *horizontal plane* is a plane paſſing through the ſpectator's eye, parallel to the horizon, cutting the *perſpective plane*, when that is perpendicular to the geometrical one, at right angles.——A *vertical plane* is a plane paſſing through the ſpectator's eye, perpendicular to the geometrical one; and uſually parallel to the perſpective plane.——An *objective plane* is any plane ſituate in the horizontal plane, whoſe repreſentation is required in *perſpective*.

There are likewiſe ſeveral different *lines* in *perſpective*, viz. *terreſtrial line*, *geometrical line*, *line of the front*, *vertical line*, *viſual line*, *line of ſtation*, *objective line*, and *line of diſtance*.——*Geometrical line*, in *perſpective*, is a right line drawn in any manner on the geometrical plane.—A *terreſtrial line*, or *fundamental line*, is a right line, wherein the geometrical plane, and that of the picture, or draught, interſect one another. Such is the line formed by the interſection of the geometrical plane, and the perſpective plane.—A *line of the front*, is any right *line*, parallel to the terreſtrial *line*.—A *vertical line*, is the common ſection of the vertical, and of the draught.—A *viſual line*, is the *line*, or ray, imagined to paſs from the object to the eye.—An *objective line*, is any *line* drawn on the geometrical plane, whoſe repreſentation is ſought for in draughts or pictures.—A *line of ſtation*, according to ſome writers, is the common ſection of the geometrical and vertical planes. Others mean by it the perpendicular height of the eye above the geometrical plane, whoſe repreſentation is ſought for in draughts or pictures.—A *line of diſtance*, is a right line drawn from the eye to the principal point: this, as it is perpendicular to the perpendiculars of the plane, or table, can only be the *diſtance* of the eye from the table.——The *point of diſtance*, in *perſpective*, is a point in the horizontal line, at ſuch *diſtance* from the principal point, as is that of the eye from the ſame.

There are other points beſides this point of diſtance in *perſpective*, viz. the *point of ſight*, the *third point*, the *objective point*, the *occidental point*, and the *viſual point*; which term *point*, is uſed for various parts, or places, with regard to the *perſpective* plane.—The *point of ſight*, or *of the eye*, is a point on the plane, marked out by a right line drawn from the eye, perpendicular to the plane: this is alſo called the *principal point*. This *point* is

in the intersection of the *horizontal* and *vertical planes*. Some authors call it the *principal point*; and give the name *point of sight*, or *vision*, to the point wherein the eye is actually placed, and where all the rays terminate.—The *third point*, is a *point* taken at discretion in the line of distance, wherein all the diagonals drawn from the divisions of the geometrical plane, concur——An *objective point*, is a *point* on a geometrical plane, whose representation is required on the *perspective* plane——An *accidental point*, is a *point* in the horizontal lines, where lines parallel to one another, though not perpendicular to the picture, or representation, meet.——A *visual point*, is a *point* in the horizontal line, wherein all the ocular rays unite. Thus a person standing in a strait long gallery, and looking forwards, the side, the floor, and ceiling seem to meet, and touch one another in a point, or common centre.

These things previously considered, I'll pass to the explanation of the different sorts of *perspective*; beginning by that of the *rectilinear perspective*, which is as follows.

Suppose a glass plane H I, (*Fig.* 1.) raised perpendicular on an horizontal plane; and the spectator S, directing his eye O, to the triangle A B C: if now we conceive the rays A O, O B, O C, *&c.* in their passage through the plane, to have their traces, or vestigia, in *a*, *b*, *c*; which, as it strikes the eye *a* O, *b* O, *c* O, by which the species of the triangle A B C, is carried to the same; it will exhibit the true appearance of the triangle ABC, tho' the object should be removed; the same distance and height of the eye being preserved.

The business of *perspective* then, is to shew by what certain rules the points *a*, *b*, *c*, &c. may be found geometrically: and hence also, we have a mechanical method of delineating any object very accurately.

Perspective is either employed in representing the *ichnographies*, and ground-plots of objects as projected on *perspective* planes; or in *scenographies*, and representations of the bodies themselves.

Ichnography in *perspective* is the view of any thing cut off by a plane parallel to the horizon, just as the base or bottom of it; so that *ichnography* is the same with what is otherwise called the *plan*, *geometrical plan*, or *ground-plot* of any thing.

Scenography, in *perspective*, is a representation of a body on a *perspective* plane; or a description thereof in all its dimensions, such as it appears to the eye. The *ichnography* of a building, *&c.* represents the plan, or ground-work of the building. The *orthography* the front, or one of the sides: and the *scenography* the whole building, front, sides, height and all, raised on the geometrical plan.

The following *lemma*'s are to be considered previously to the general laws we are to establish, of both *ichnographick* and *scenographick perspective*.

1. That the appearance of a right line is ever a right line; whence the two extremes being given, the whole line is given.——2. That if a line be perpendicular to any right line drawn on a plane, it will be perpendicular to every other right line thro' the same point drawn on the same plane.——3. That the height of the point appearing on the plane, is to the height of the eye, as the distance of the objective point from the plane, to the aggregate of that distance and the distance of the eye.

Now for the *laws of the projection of plane figures*, or *ichnographick perspective*, which are as follow.

The perspective appearance, h, *by an objective point H*, (Fig. 2.) is exhibited, by drawing, from the given point; H I, perpendicular to the fundamental line D E; cutting from that fundamental line I K = H I: drawing through the point of sight F, a horizontal line F P; and making F P, equal to the distance of the eye S L: Lastly, drawing from the point I to the point of sight F, the point F I; and from K to the point of distance P, the line P K. The intersection *h* is the appearance of the objective point. Hence,

1. Since the appearance of the extreme points or a right line being given, the appearance of the whole line is given; the *ichnographick* projection of any rectilinear figure may be had by this method.

2. Since any number of points of a curve line may by this means be projected on the *perspective* plane; the projection of curve lines may likewise be effected after the same manner.

3. Therefore, this method will suffice for rectilinear figures; and is consequently universal. There are indeed other methods delivered by other authors, but this is the most usual; the *force* and *effect* whereof may be illustrated by the following examples; *viz.*

If we want to *find the perspective appearance of a triangle*, A B C (Fig. 4.) *whose base* A B, *is parallel to the fundamental line* D E; to that fundamental line, we'll draw a parallel at an interval equal to the altitude of the eye. Taking a fundamental point V, opposite to this either directly or obliquely, as the case requires; transferring the distance of the eye from U to K, letting fall from the several angles of the triangles A C B, the perpendiculars A 1, C 2, B 3; and setting off these perpendiculars upon the fundamental line D E, opposite to the point of distance K, drawing from 1, 2, 3, right lines to the fundamental or principal point U 1, U 2, U 3, and from the points A, B and C of the fundamental line D E, other right lines A K, B K, C K, to the point of distance K.

Since *a*, *b* and *c* are the appearances of the points A B and C; the right lines *c a*, *a b* and *b c*, being drawn, *a c b* will be the appearance of the triangle A C B.

After the same manner is a triangle projected on a plane, where the vertex C is opposed to the eye: all here required is, that its situation on the geometrical plane be changed, and the vertex C turned towards the fundamental line D E.

When we want to *exhibit the perspective appearance of a square* A B D C (Fig. 5.) *seen obliquely, and having one of its sides* A B *in the fundamental line.* The square being viewed obliquely, we assume the principal point U in the horizontal line K R, in such a manner as a perpendicular to the fundamental line falling without the side of the square A B, at least, may not bisect it; making U K the distance of the eye. Then we'll transfer the perpendiculars A C and B D to the fundamental line D E, drawing the right lines K B, K D, as also A U, U C. Then will A and B be their own appearances, and *c* and *d* the appearances of the points C and D; consequently A *c d* B is the appearance of the square A B D C.

If the square A C B D should be at a distance from the fundamental line D E; which yet rarely happens in practice; the distances of the angles A and B must likewise be transferred to the fundamental line; as is evident from the preceding problem. And since even the oblique view is not very common; in what follows we shall always suppose the figure to be posited directly opposite to the eye, unless where the contrary is expressly mentioned.

We exhibit the *appearance of a square* A B C D (*Fig.* 6.) *whose diagonal* A C, *is perpendicular to the fundamental line*; by continuing the sides D C and C B, till they meet the fundamental line in 1 and 2, setting off from the principal point U, the distance of the eye to K and L; drawing from K to A and 1, the right lines K A and K 1; and from L to A and 2, the right lines L A, L 2. Then the intersections of those lines exhibit the appearance of the square A B C D viewed angle wise.

Intersection is the cutting of one line or plane by another; or the point or line wherein two lines or two planes cut each other. The mutual intersection of two planes is a right line. The center of a circle is in the intersection of two diameters. The central point of a regular or irregular figure of four sides, is the point of intersection of the two diagonals.

When we want to exhibit the *appearance of a square* A B C D (Fig. 7.) *wherein another square* I M G H, *is inscribed, the side of the greater* A B, *being in the fundamental line; and the diagonal of the less perpendicular to the fundamental:* from the principal point U, we must set off each way, on the horizontal line H R, the distances U L and U K, and by drawing U A and U B, and K A and L B; A *c d* B will be the appearance of the square A C D B. Then by producing the side of the inscribed square I H, till it meets the fundamental line in 1; and drawing the right lines K 1, and K M; *i h g* M will be the representation of the inscribed square I H G M. Hence is easily conceived the projection of any figures inscribed in others.

Projection in *perspective* denotes the appearance or representation of an object on the *perspective* plane. The *projection*, e. gr. of a point, is a point through which the optick ray passes from the objective point through the plane to the eye; or it is the point wherein the plane cuts the optick ray. And hence is easily conceived what is meant by the *projection* of a line, a plane, or a solid.—The *projection of the sphere in plano* is a representation of several points or places of the surface of the sphere, and of the circles described thereon, or of any assigned parts thereof, such as they appear to the eye situate at any given distance, upon a transparent plane placed between the eye and the sphere.—The principal use of the *projection of the sphere* is in the construction of planispheres, and particularly maps and charts, which are said to be of this or that *projection*, according to the several situations of the eye, and the *perspective* plane with regard to the meridians, parallels, and other points and places to be represented.—The *projection of the sphere* is usually divided into *orthographick* and *stereographick*.

Orthographick projection is that wherein the superficies of the sphere is drawn on a plane, cutting it in the middle; the eye being placed at an infinite distance vertically to one of the hemispheres.—The *laws* of this sort of *projection*, are these: 1. The rays by which the eye at an infinite distance perceives any object, are parallel. 2. A right line perpendicular to the plane of the *projection*, is projected into a point, where that right line cuts the plane of the *projection*. 3. A right line not perpendicular, but either parallel or oblique to the plane of the *projection*, is projected into a right line, and is always comprehended between the extreme perpendiculars. 4. The *projection* of the right line is the greatest, when that line is parallel to the plane of the *projection*. 5. Hence it is evident, that a line parallel to the plane of the *projection*, is projected into a right line equal to itself; but if it be oblique to the plane of the *projection*, it is projected into one which is less. 6. A plane surface, at right angles to the plane of the *projection*, is projected into that right line, in which it cuts the

plane of the *projection*. Hence it is evident, that a circle ſtanding at right angles to the plane of the *projection* which paſſes through its center, is projected into that diameter, in which it cuts the plane of the *projection*. 7. A circle parallel to the plane of the *projection*, is projected into a circle equal to itſelf; and a circle oblique to the plane of the *projection*, is projected into an ellipſis.

Stereographick projection, is that wherein the ſurface and circles of the ſphere are drawn upon the plane of a great circle, the eye being in the pole of that circle. As to the *properties of this ſort of projection*. 1. In this *projection* a right circle is projected into a line of half tangents. 2. The repreſentation of a right circle perpendicularly oppoſed to the eye, will be a circle in the plane of the *projection*. 3. The repreſentation of a circle placed obliquely to the eye, will be a circle in the plane of *projection*. 4. If a great circle is to be projected on the plane of another great circle, its center will lie in the line of meaſures, diſtant from the center of the primitive by the tangent of its elevation above the plane of the primitive. 5. If a leſſer circle, whoſe poles lie in the plane of the *projection* were to be projected; the center of its repreſentation would lie in the line of meaſures, diſtant from the center of the primitive, by the ſecant of the leſſer circles diſtance from its pole, and its ſemi-diameter or radius be equal to the tangent of that diſtance. 6. If a leſſer circle were to be projected, whoſe poles lie not in the plane of the *projection*, its diameter in the *projection*, if it falls on each ſide of the pole of the primitive, will be equal to the ſum of the half tangents of its greateſt and neareſt diſtance from the pole of the primitive, ſet each way from the center of the primitive in the line of meaſures. 7. If the leſſer circle to be projected, falls entirely on one ſide of the pole of *projection*, and do not encompaſs it; then will its diameter be equal to the difference of the half tangents of its greateſt and neareſt diſtance from the pole of the primitive, ſet off from the center of the primitive one, and the ſame way in the line of meaſures. 8. In the *ſtereographick projection*, the angles made by the circles of the ſurface of the ſphere, are equal to the angles made by their repreſentations in the plane of their *projection*.

To exhibit the perſpective of a pavement, conſiſting of ſquare ſtones directly. We muſt divide the ſide A B (*Fig.* 8.) transferred to the fundamental line DE into as many equal parts as there are ſquare ſtones in one row, drawing from the ſeveral points of diviſion, right lines to the principal point U; and from A to the point of diſtance K, a right line AK; and from B to the other point of diſtance L, another LB. Drawing likewiſe through the points of the interſections of the corresponding lines, right lines on each ſide to be produced to the right lines A U, and B U; then will A *f g* B be the appearance of the pavement A F G B.

For the *exhibition of the perſpective of a circle.*—If the circle be ſmall, we'll circumſcribe a circle about it; draw the diagonals and diameters *b a* and *d e* (*Fig.* 9.) interſecting each other at right angles; and the right lines *f g* and *b c* parallel to the diameter *d e* through *b* and *f*; drawing alſo through *c* and *g* right lines meeting the fundamental line DE in the points 3 and 4, to the principal point V, we'll draw the right lines V 1, V 3, V 4, V 2; and to the points of the diſtance L and K, the right lines L 2 and K 1. Laſtly, connecting the points of interſection *a*, *b*, *d*, *f*, *h*, *g*, *e*, *c*, with arches *a b*, *b d*, *d f*, &c. thus will *a*, *b*, *d*, *f*, *h*, *g*, *e*, *c*, *a*, be the appearance of the circle.

If the circle be large, on the middle of the fundamental A B (*Fig.* 10.) we'll deſcribe a ſemicircle; and from the ſeveral points of the periphery, C, F, G, H, I, &c. to the fundamental line, we'll let fall perpendiculars C 1, F 2, G 3, H 4, I 5, &c. drawing from the points A, 1, 2, 3, 4, 5, &c. right lines, to the principal point V, as alſo a right line from B, to the point of diſtance L; and another from A to the point of diſtance K, drawing alſo through the common interſections, right lines as in the preceding problem: thus ſhall we have the points *c*, *f*, *g*, *h*, *i*, which are the repreſentation of thoſe A, C, F, G, H, I, which being connected as before, give the projection of the circle.

Hence appears not only how any curvilinear figure may be projected on a plane, but alſo how any pavement conſiſting of any kind of ſtones, may be delineated in *perſpective*.

Hence alſo appears what uſe the ſquare is of in *perſpective*, for even in the ſecond we uſe a ſquare divided into certain *areolæ*, and circumſcribed about the circle; though it be not delineated on the geometrical plane in the *diagram*.

Diagram is a ſcheme for the explanation or demonſtration of any figure, or the properties thereto belonging.

If *we want to exhibit the perſpective of a regular pentagon, having a broad limb terminated by lines parallel thereto.*——1. From the ſeveral angles of the exterior pentagon A, B, C, D, E, (*Fig.* 11.) to the fundamental line T S, we'll let fall perpendiculars A 0, B 1, C 2, D 3, E 4; which, as in the former, we'll transfer to the fundamental line. Connecting the points 1, 2, 3, 4, to the principal point V; and the points 1, 2, 3, 4, to the point of diſtance K. Thus will the common interſections repreſent the appearance of the exterior pentagon.

2. If

2. If now from the inner angles G H L I, the perpendiculars G 0, H 5, K 6, I 7, L 8, be in the like manner let fall; and the reſt be done, as in the former; we ſhall have the repreſentation of the inner pentagon. The pentagon A B C D E, therefore, with its limb, is repreſented in *perſpective*.

As to the doctrine of *ſcenographick perſpective*, or the projection of bodies on a plane it is as follows.

1. On a *given point* C (*Fig.* 13) *to raiſe a perſpective altitude*, anſwerable to the given objective altitude, P Q; we muſt raiſe on the fundamental line, a perpendicular P Q, equal to the given objective altitude: drawing right lines P T, and Q T, from P and Q to any point, as T; and from the given point C, a line C K, parallel to the fundamental line D E; and meeting the right line Q T in K, where we'll erect a perpendicular to K C, *viz.* I K; this I K is the *ſcenographick* altitude required.

2. If we want to exhibit the *perſpective* of a ſolid. We muſt find the projection of its baſe in the ichnographick *perſpective*, and in the ſeveral points thereof erect the *perſpective* altitude: thus will the *ſcenography* of the ſolid be finiſhed, except for what relates to the ſhadow. For example.

To *exhibit the ſcenographick perſpective of a cube, viewed angle-wiſe.*——Since the baſe of a cube viewed angle-wiſe, and ſtanding on a geometrical plane is a ſquare viewed angle-wiſe; draw a ſquare on the *perſpective* plane, after the manner laid down above; raiſe the ſide of the ſquare H I (*Fig.* 15.) perpendicularly in ſome point of the fundamental line D E; and to any point V, of the horizontal line H R, draw right lines V I, and V H. From the angles *d b* and *c*, draw *c* 1, *d* 2, parallel to the fundamental line D E, from the points 1 and 2, raiſe L 1 and M 2 perpendicular to the ſame. Laſtly, ſince H I is the altitude to be raiſed in *a*, L 1 in *c*, and *b* and M 2 in *d*; in *a* raiſe *f a*, perpendicular to *a* E; and in *b* and *c* raiſe *b g*, and and *c e*, perpendicular to *b c* 1; and laſtly *d b* perpendicular to *d* 2; and let *a f* be equal to H I, *b g* = *e c* = L 1, and *b d*, to M 2; if then the points *g*, *h*, *e*, *f*, be connected by right lines, the *ſcenography* will be finiſhed.

This method is general, but its application is not equally obvious in every caſe; therefore we muſt enter into a more particular illuſtration thereof, by a few other examples, *viz.*

To *exhibit the ſcenography of a cube, viewed by an angle.*—1. As the baſis of a cube viewed by an angle, ſtanding on a geometrical plane, is a ſquare viewed by an angle; draw a ſquare viewed angular-wiſe, on the *perſpective* table, or plane. 2. Raiſe the ſide H I (*Fig.* 14.) of the ſquare, perpendicularly on each point of the terreſtrial line D E; and to any point as V, of the horizontal line H R, draw the right line V I and V H. 3. From the angles *d*, *b*, and *c*, draw *c* 1, *d* 2, &c. parallel to the terreſtrial line D E. 4. From the points 1 and 2, raiſe L 1, and M 2, perpendicular to the ſame. Laſtly, ſince H I is the height to be raiſed in *a*, L I in *c* and *b*, and M 2 in *d*; in *a*, raiſe the line *f a* perpendicular to *a* E; in *b* and *c*, raiſe *b g* and *c e* perpendicular to *b c* 1; and laſtly, raiſe *d b* perpendicular to *d* 2; if then the points *g*, *h*, *e*, *f*, be connected by right lines, the *ſcenography* will be compleat.

The *ſcenography of a hollow quinquangular priſm*, is exhibited thus. 1. Since the baſe of a hollow quinquangular priſm, ſtanding on a geometrical plane, is a pentagon, with a limb or breadth of a certain dimenſion, the appearance of this pentagon muſt be found on a table or plane. 2. On any point, as H, of the terreſtrial line D E (*Fig.* 15.) a perpendicular H I muſt raiſed equal to the objective altitude; and to any point, *a v* of the horizontal line H, the lines H V, and I V, are to be drawn. 3. From the ſeveral angles *a*, *b*, *d*, *e*, *c*, of the *perſpective* inchnography, both the internal and external ones, muſt be drawn right lines, as *b* 2, *d* 3, &c. parallel to the terreſtrial line; and from the points 1, 2, 3, perpendiculars raiſed to the ſame, as L 1, M 2, *m* 2, N 3, *n* 3. If theſe then be raiſed in the correſpondent points of the ichnography, as in the preceding article, the *ſcenography* will be compleat.

As to the *exhibition of the ſcenography of a cylinder.*—1. Since the baſe of a cylinder, ſtanding on a geometrical-plane, is a circle; ſeek the appearance of a circle. In the points *a*, *b*, *d*, *f*, *g*, *b*, *e*, *c*, the *ſcenography* of the circle will be compleat.

It is evident, that thoſe lines are to be omitted, both in the plan and in the elevation, which are not expoſed to the eye; though they are not to be diſregarded from the beginning, as being neceſſary for the finding of other lines. As for example, in the *ſcenography* of the cube, viewed angle-wiſe, the lines *b d*, and *d c*, in the baſe, and *d b* in the elevation, are hid from the eye, and are therefore omitted in the deſcription. But ſince the upper point *h* is not to be found, unleſs the point *d* be had in the ichnography; nor can the lines *g h* and *d e*, be drawn without the height *d b*; the appearance of the point *d* is as neceſſary to be determined in the operation, as the height *h d*.

To *exhibit the ſcenography of a pyramid ſtanding on its baſe.*—Suppoſe, *e*, *gr*, it were required to delineate a quadrangular pyramid, viewed by an angle. 1. Since the baſe of ſuch pyramid is a ſquare, ſeen by an angle, we muſt draw ſuch a ſquare. 2. To find the vertex of the pyramid, *i. e.* a perpendicular

pendicular let fall from the vertex to the base, we'll draw diagonals mutually intersecting each other in *e*. 3. On any point, as H, of the terrestrial line D E, raise the altitude of the pyramid H I; and drawing the right lines H V and I V, to each point of the horizontal line H R; we'll produce the diagonal *a b*, till it meets the line V H in *h*. Lastly, from *h* we'll draw *h i* parallel to H I; this being raised on the point *e*, will give the vertex of the pyramid K; consequently the lines *d k*, *k a*, and *k b*, will be determined at the same time. After the like manner is the *scenography* of a cone delineated.

If it be the *scenography of a truncated pyramid, it is exhibited thus.*—Suppose the truncated pyramid quadrangular: 1. Then, if from the several angles of the upper base be conceived perpendiculars let fall to the lower base, we shall have a pentagon, with another inscribed therein, whose sides are parallel to those of the former. This coincides with a pentagon, furnished with a rim or breadth, *&c.* and may, therefore, be delineated in the same manner. Raising the altitude of the truncated pyramid I H, determines the *scenographick* altitudes, to be raised in the points *a*, *b*, *c*, *d*, *e*. If now the points higher, *f*, *g*, *h*, *i*, *k*, be connected by right lines; and the lines *l k*, *f m*, *g n*, *h o*, be drawn, the *scenography* will be compleat. By drawing two concentrick circles in a geometrical plane, and doing every thing else, as in this problem, the *scenography* of a truncated cone will be drawn.

To *exhibit the scenography of walls, columns, &c. or to raise them on the pavement.* 1. Suppose a pavement A F H I, represented in a plan, together with the bases of the columns, *&c.* if there be any. 2. Upon the terrestrial line set off the thickness of the wall B A and 1, 3. 3. Upon A and B, as also upon 3 and 1, raise perpendiculars A D and B C, as also 3, 6, and 1, 7. 4. Connect the points D and *b*, with the principal point V, by the right lines D V and *b* V. 5. Upon F and H raise perpendiculars H G and E F: thus will all the walls be delineated.

How to raise the pillars, *&c.* there needs nothing but from their several bases (whether square or circular) projected on the perspective plane, to raise indefinite perpendiculars; and on the fundamental line, where intersected by the radius F A passing through the base, raise the true altitude A D; for D V being drawn as before, the *scenographical* altitudes will be determined.

To *exhibit the scenography of a door in a building.*—Suppose a door required to be delineated in a wall D E F A. 1. Upon the fundamental line set off its distance A N, from the angle A, together with the breadths of the posts N I and L M, and the breadth of the gate itself L I. 2. To the point of distance K, from the several points N, I, L, M, draw right lines K N, K I, K L, K M, which will determine the breadth of the door *l i*, and the breadth of the posts *i n* and *m l*. 3. From A to O set off the height of the gate A O, and from A to P, the height of the posts A P. 4. Join O and P with the principal point, by the right lines P V and O V. 5. Then from *n*, *i*, *l*, *m*, raise perpendiculars, the middle ones whereof are cut by the line O V in *o*, and the extremes, by the right line V P in *p*. Thus will the door be delineated with its posts. If the door were to have been exhibited in the wall E F G H, the method were nearly the same: For, 1. Upon the terrestrial line, set off the distance of the door from the angle, and thence also the breadth of the door, R T. 2. From R and T, draw right lines to the principal point V, which give the breadth *r t* in the perspective plane. 3. From *r* and *t* raise indefinite perpendiculars to F H. 4. From A to O set off the true height A O. Lastly, from O, to the principal point V, draw the right line O V, intersecting E F in Z, and make *r r* and *t t* equal to F Z. Thus is the door *r r*, *t t*, drawn; and the posts are easily added as before.

When you know how to represent doors, you will find no difficulty in adding windows; all that is here farther required, being to set off the height of the window from the bottom of the ground. The whole operation is as follows: 1. From 1 to 2 set off the thickness of the wall at the window; and from 3 to 4 its distance from the angle 3; and from 4 to 5 its breadth. 2. From 4 to 5, to the point of distance L, draw the right lines L 5 and L 4, which will give the perspective breadth 10, 9 of the window. 3. From 10 and 9 raise lines perpendicular to the pavement, *i. e.* draw indefinite parallels to *b*, 3. 4. From 3 to 11 set off the distance of the window from the pavement 3, 11; and from 11 to 12, its height 11 12. Lastly, from 11 and 12, to the principal point V, draw lines V 11, and V 12; which intersecting the perpendiculars 10, 13, and 9, 14, in 13 and 14, as also in 15 and 16, will exhibit the appearance of the window.

In exhibiting the perspective of a building. 1. Take the ichnography or ground-plot of the building; its length, breadth and depth, by actual measuring, and take its altitude with a quadrant.

2. Make a scale divided into two or three hundred equal parts, either actually, or so as that each division signify ten parts: by this scale lay down the ground-plot.

3. This done, having a long rule, and a square, which by sliding on the rule helps you to draw your perpendiculars with more facility, reduce it into *perspective*, in its scenographick appearance.

Then

Then having drawn a line towards the bottom of the paper for the front or baſe line, divide it into as many equal parts as you find the building has in the ichnography, or more if you pleaſe. This will ſerve for a ſcale to determine the ſeveral heights, &c. and to theſe diviſions, with a black lead pencil draw lines from the centre, when you have choſen it; which choice requires judgment on two accounts.

4. Conſider how to place this center with ſuch advantage, as that you may expreſs thoſe things moſt, which are chiefly deſigned.

Place thoſe things you would ſee leaſt of, nigheſt the direct line; and ſee whether the others fall according to your mind. But this muſt be done after you have drawn your diagonal, which is the next thing.

5. Having pitched on your center, and having from it drawn lines to every diviſion of the front line, you are to determine your diagonal A R thus: having with a pair of compaſſes, meaſured the length of the front line, take your compaſſes, and putting one foot in the center, ſee where the other will reach in the horizon, (on both ſides if you pleaſe) where it reſts; from that point draw athwart line to the laſt diviſion of the front; and this will be truly drawn, or pretty nigh to the truth. That it is ſo you may conſider how it falls in reſpect of the two laſt center-lines. For if where the next line from the laſt is interſected by the diagonal you draw a parallel, the front between them, you will have a rhombus; if then all the ſides be pretty equal, you may be ſure you are nigh the right; but if the ſides that run towards the center be too long, then things will not fore-ſhorten enough; if the ſides be not long enough, they will fore-ſhorten too much.

6. After the front line is thus divided, the center fixed, and the diagonal placed, take the breadth of the chapel, A B, which in the ichnography is ſhewn to be twenty parts; becauſe this line is perpendicular, it muſt run towards the center, therefore reckon twenty in the diagonal, and the rule laid parallel to the front in that point, will give you a point in the center-line, which will give the breadth of the chapel; conſequently a line drawn from A to B, puts it into the ichnographick *perſpective*. The length of the chapel being ſeventy diviſions in the front line, reckon ſeventy from B, parallel to the front line, and there you will have a point at C.

The depth of the building, from the chapel northward, being one hundred and fifteen from the chapel, I reckon from D; (where it cuts the diagonal at ten) onwards, in the diagonal; and at one hundred and fifteen in the diagonal, with my rule as before parallel in this place in the front, I have the point Z in the central line. Its breadth being thirty, I reckon three diviſions, and there is the juſt breadth there; and ſo on in every particular part.

Having placed the ichnography into *perſpective*, you may then give every thing its proper height thus:

7. The height of the chapel being thirty, I reckon thirty on the front line, and with this length by a ſquare clapt to the front line, I drop a perpendicular to that height; and ſo where the other ſide of the chapel is placed, having reckoned the height upon a ſuppoſed parallel, there I draw another line in that height; then joining theſe ſeveral heights by ſeveral lines, you have the *profiles* of each building.

Profile is the figure or draught of a building, fortification, or the like, wherein are expreſſed the ſeveral heights, widths, and thickneſſes, ſuch as they would appear, were the building cut down perpendicularly from the roof to the foundation. Whence the *profile* is alſo called the *ſection*, ſometimes *orthographical ſection*; and by *Virtruvius* alſo *ſciagraphical*.

Having done thus, your art muſt be employed for the particular expreſſions of things, by drawing and ſhadowing, which is the life of this half-form'd figure, which we leave to the painter.

It remains, that we ſpeak of the low ſight: and here we ſuppoſe the horizontal line juſt the height of the eye, about five foot from the baſis; though its is generally placed higher, even to a third part of the height of the building, that the ſide building may be expreſſed more gracefully.

The diagonal is beſt determined by dividing the laſt diviſion of the baſe-line into five parts, taking four of theſe, ſometimes the whole five, becauſe we determined before, that the length of the front line was the diſtance of the eye in the horizon, between the eye and the point of diſtance. You may then either graduate the plan at the ſeveral interſections of the diagonals with the center lines, or elſe ſuppoſe it ſo, and then raiſe the buildings, as you will find by *perſpectives* enough of this ſort every where to be met with.

PHILO-

PHILOSOPHY.

PHILOSOPHY is a *Greek* derivative, signifying the knowledge or ſtudy of *nature* and *morality*, founded on reaſon and experience.

Philoſophy, among the antients, was uſed in various ſenſes: for, 1. It ſometimes was taken for univerſal knowledge, *viz.* of all things *human* and *divine*. 2. In a ſtricter notion, for the contemplation of *nature* only; and in this ſenſe a philoſopher was called by *Plato* φιλος της φυσεως, *i. e.* a friend and lover of nature. 3. Sometimes for *ethics*, or the doctrine of *manners*, which we call *moral philoſophy*. 4. It included alſo the *mathematical* arts and diſcipline, eſpecially *arithmetic* and *geometry*. 5. The doctrine of exiſtence, or *being* in the abſtract, called *metaphyſics*. 6. For the knowledge του πρωτου καλου, *i. e.* of the prime or chief good, *viz.* GOD; and this was their *prima philoſophia*, or *theology*. 7. It was ſometimes applied to *logics* or *dialectics*, which gave rules for *reaſoning* about the nature of things.

PHILOSOPHY may be divided into three parts, *intellectual*, *moral*, and *phyſical*. The *intellectual* part comprizes *logics* and *metaphyſics*; the *moral* part contains the *laws* of *nature* and *nations*; and, laſtly, the *phyſical* part comprehends the doctrine of *bodies* animate or inanimate. Theſe, with their various ſubdiviſions, will take in the whole of philoſophy.

From the firſt broachers of new opinions, and the firſt founders of ſchools, philoſophy is become divided into innumerable ſects, ſome antient, others modern; ſuch are the *Platoniſts*, *Peripatetics*, *Epicureans*, *Stoics*, *Pyrrhonians*, and *Academics*; the *Carteſians*, *Newtonians*, &c.

The riſe and doctrines of theſe ſeveral ſchools, will be beſt learned from the lives of *Socrates*, *Plato*, *Ariſtotle*, *Epicurus*, &c. In thoſe authors, who have profeſſedly employ'd their talents in conveying their memoirs and opinions to poſterity.

It may here ſuffice to obſerve in this place, that the name of a philoſopher, in itſelf compos'd of modeſty and ſimplicity, appear'd ſo fine, and ſo glorious to the learned in antient times, that they preferr'd it to the proudeſt titles, and the moſt illuſtrious characters of honour. That love of wiſdom, and that ſtudy of nature which they profeſs'd, gave them ſuch an authority over the ſpirits of men, that their example ſerv'd for a publick inſtruction, and their maxims were received as oracles in the world. Great men and governors applied to them for advice in affairs of the laſt importance: cities and provinces ſubmitted to their conduct; and princes themſelves eſteem'd it a glory to have been their diſciples. It was philoſophy which taught *Pythagoras* that integrity of morals, and that ſevere courſe of life, which drew after him ſo numerous a train of followers. It was this that gave *Empedocles* the honour of refuſing a crown, and of preferring a private and peaceable life to all the pomp of greatneſs. By this, *Democritus* rais'd himſelf to the contemplation of natural things, and renounced the pleaſures of the body, to enjoy thoſe of the mind with greater freedom and tranquillity. It was this that enabled *Socrates* to die without arrogance on the one hand, or weakneſs on the other. If there appear leſs temper and leſs modeſty in the death of *Cato*, who ſeems to have over-acted the philoſopher, yet we may obſerve in that, ſome ſtrokes of gallantry and greatneſs of ſoul, which could inſpire him with ſuch an utter contempt of life. And ſince there is ſcarce one action of bravery and reſolution recorded in *Pagan* ſtory, but what was owing to the ſpirit of philoſophy, we may affirm this to have been, in ſome ſort, the motive and principle of the brighteſt virtue that ever ſhone among the corruptions of *heathens*.

Thales and *Pythagoras* were, properly ſpeaking, the two great founders of philoſophy among the antients; the one in *Greece*, the other in *Italy*. In the ſchool of *Pythagoras*, we find ſomewhat more regular and ſolid, than in that of *Thales*, and his ſucceſſors. *Pythagoras*'s whole doctrine being conceiv'd as a myſtery, the chief character of his ſcholars was ſubmiſſion; and that religious ſilence, to which he ſo ſtrictly obliged them, was but an artifice to make himſelf heard with more entire reſpect. This philoſopher's life is at preſent a ſubject of controverſy, as well as his opinion. He muſt no doubt, have been a man of profound capacity, of a moſt penetrating judgment, and moſt indefatigable induſtry. His common method of teaching, was by geometry and numbers; by the former he explain'd material and ſenſible things, as he did intellectual things by the latter, and by muſick.

Socrates was the firſt that ever began to reduce the confuſed ideas of his predeceſſors into ſome method and order, by ranging their natural obſervations under proper heads, ſo as to render them uſeful in the forming of arts and ſciences. Beſides all that agreeableneſs of wit which ariſes from a facility

facility of genius and felicity of parts, he had all the depth, and all the ſolidity imaginable; and yet this height of underſtanding, and this abundance of light, was attended with true ſimplicity, and infant meekneſs. While really engaged in every thing, he ſeem'd wholly unemploy'd; he preſerv'd an air of pleaſantry in treating of the graveſt ſubjects; and his moſt ſerious meditations never robb'd him of his good humour.

But as he was the leader of all the ſects; ſo he was in ſome ſort, the author of all their heats and diviſions. For his reaſonings were commonly level'd againſt reaſon; and while he eſtabliſh'd the ſciences, he left the means of deſtroying them, the common reſult of his inſtructions being rather doubt than aſſurance, in his hearers. But he muſt ſtill be allow'd to have contributed much to that form and character which philoſophy took ſoon after. For 'twas he that firſt traced out the plan of logick and morality, and ſupplied principles to phyſicks. Yet the peculiar bent of his genius, which carried him to ſeek for too much nicety, and to refine upon every thing, was the reaſon that he handled theſe matters with leſs ſolidity than his ſucceſſors. Not but that his authority is of very great weight, when he advances any point; but his conceptions are, for the moſt part, rather principles than deciſions; and upon the whole, his philoſophy ſeems much more proper to pull down than to build.

Plato is the fineſt ſpeaker of all antiquity, and therefore he is more deſirous to be heard, than ſollicitous to be believ'd, he is always florid, but not always ſound.

He rais'd the credit of his philoſophy more by the virtues of his life and conduct, than by his ſpeculations of doctrine. For it was he who firſt taught, that true philoſophy conſiſted more in fidelity and conſtancy, in juſtice and ſincerity, and the love of our duty, than in large attainments, or uncommon parts.

Ariſtotle is a genius ſo much above the ſtandard, as not eaſily to be comprehended. By a prodigious and unexpected reach of knowledge, he advances beyond all bounds, and conquers all oppoſitions. He was the firſt that gather'd the various parts of philoſophy, in order to the re-uniting them in one body, and caſting them into a regular ſyſtem. No man ever had ſo clear, and ſo piercing a diſcernment of true and falſe.

Ariſtotle is certainly the man that has given the greateſt weight to human reaſon, and carried it to its farthеſt length. And then, his method is more ſolid than that of all others, becauſe his principles are eſtabliſh'd upon better reaſon, and his reaſon founded upon better experience. Yet he choſe to deliver himſelf with obſcurity; whether to conceal his doubts, or to increaſe his authority, is not certain. He ſeems to have written that he might not be underſtood; and his works look as if deſign'd not ſo much for the inſtruction of his own age, as for the exerciſe of all ages to come.

If we examine the motives by which the greateſt part of philoſophers are determin'd to their peculiar ſect, we ſhall find that philoſophy has the leaſt ſhare in them. 'Tis often by prevention of age, or accident, without deliberation, or choice, and ſometimes without thought, that they embrace one opinion rather than another. Men come to agree in the ſame perſuaſion, by the habit they wear, the nation to which they belong, the company they keep; by the way of life that firſt engages them, by the ſociety that firſt gains and poſſeſſes them, by the multitude that carries them along, by the ſtream that bears them down; and by any conſiderations, except thoſe of reaſon and wiſdom. Thus they ſubmit to the tyranny of prepoſſeſſion, as not having ſtrength of judgment to ſtem and reſiſt it: they abandon their own ſenſe, to follow other mens fancies: they purſue with paſſion what they have undertaken without reaſon; and defend with the utmoſt temerity what they firſt embraced by mere chance and prevention. And when they have once fix'd, they make it a point of honour to maintain their ground. Nay, it ſometimes happens, that the animoſity and contention of parties ſharpens the dulleſt wits, and vexation ſupplies the place of underſtanding. But thus raſhly and fortuitouſly to make our ſelves the properties and acceſſions of other mens conceits, has ſo very ridiculous an air, that 'tis better to be any thing than ſuch a tool of a philoſopher. Between theſe oppoſitions of ſcience, we ought to ſtand in our own defence, and not tamely to yield upon the bare ſummons of any party. For ſuch an ungrounded and precarious philoſophy is a diſtemper of mind, and a mere intellectual debauch.

Truth is ſo hardly beſet, and brought under ſuch a ſtate of perſecution, by the falſe colours of the age, that few men have ingenuity enough to ſpeak their mind, or reſolution enough to be ſincere. It requires a good degree of courage to be a philoſopher in good earneſt. Nay, it ſhews an uncommon greatneſs of ſoul, never to ſpeak but what we think, and never to think but what we dare to ſpeak.

PLUMBERY.

PLUMBERY, from the Latin *plumbum*, lead, is the art of caſting, preparing, and working lead, and of uſing it in buildings, *&c.*

The lead uſed in *plumbery* is furniſhed from the lead-works in large ingots, or blocks, called pigs of lead, ordinarily weighing about a hundred pounds a piece. As this lead melts very eaſily, it is eaſy to caſt figures thereof of any kind, by running it into moulds of braſs, clay, plaſter, *&c.*

But what makes the baſis of the plumbers work in building, are the *ſheets* and *pipes* of lead.

The lead deſigned for *caſting large ſheets*, is melted in a furnace, uſually built with free ſtone, and earth, fortified on the outſide with maſſive of ſhards and plaſter. At the bottom is a place ſunk lower than the reſt, wherein is depoſited an iron pot, or pan, to receive what may remain of the metal after the ſheet is run. The furnace is ſo raiſed above the area of the floor, as that the iron pot juſt reſts thereon.

The furnace is heated with wood laid within it, throwing afterwards into it the lead, pell-mell with the burning coal to melt.

Near the furnace is the table, or mould, whereon the lead is to be caſt. It conſiſts of large pieces of wood, well joined, and bound with bars of iron at the ends. Around it runs a frame, conſiſting of a ledge or border of wood two or three inches thick, and one or two high from the table, called the *ſharps*. The ordinary width of the tables is from three to four feet; and their length from 18 to 20 feet.

The table is covered with fine ſand, prepared, by moiſtening it with a watering pot, then working it with a ſtick; and at laſt to render it ſmooth and even, beating flat with a mallet, and planing it with a ſlip of braſs or wood.

Over the table is a ſtrike or rake of wood, which bears and plays on the edges of the frame by means of a notch cut in either end thereof; and ſo placed, as that between it and the ſand is a ſpace proportionable to the intended thickneſs of the ſheet. The uſe of this ſtick is to drive the matter, while yet liquid, to the extremity of the mould.

A-top of the table is a triangular iron peel or ſhovel, bearing before, on the edge of the table itſelf, and behind on a treſtle ſomewhat lower than the table. Its uſe is to convey the metal into the mould; and the deſign of its oblique diſpoſition is, that it may by that means be able to retain the metal, and keep it from running off at the fore ſide, where it has no ledge. Some of thoſe peels are big enough to hold fifteen or ſixteen hundred weight of lead, and even more.

Things being thus diſpoſed, with a large iron ladle they take the melted lead, coals and all, out of the furnace; and with this, mixed as it is, fill the iron peel. When full, they take out the coals, and clear the lead with another iron ſpoon pierced after the manner of a ſkimmer.

This done, they hoiſt up the lower part of the peel by its handle; upon which the liquid matter running off, and ſpreading itſelf on the mould, the plumber conducts and drives it to the extremity of the table by means of the ſtrike, which the workmen paſſes along the ledges, and thus renders the ſheet of an equal thickneſs.

The ſheets thus caſt, there remains nothing but to edge them, *i. e.* to planiſh the edges on both ſides, in order to render them ſmooth and ſtrait.

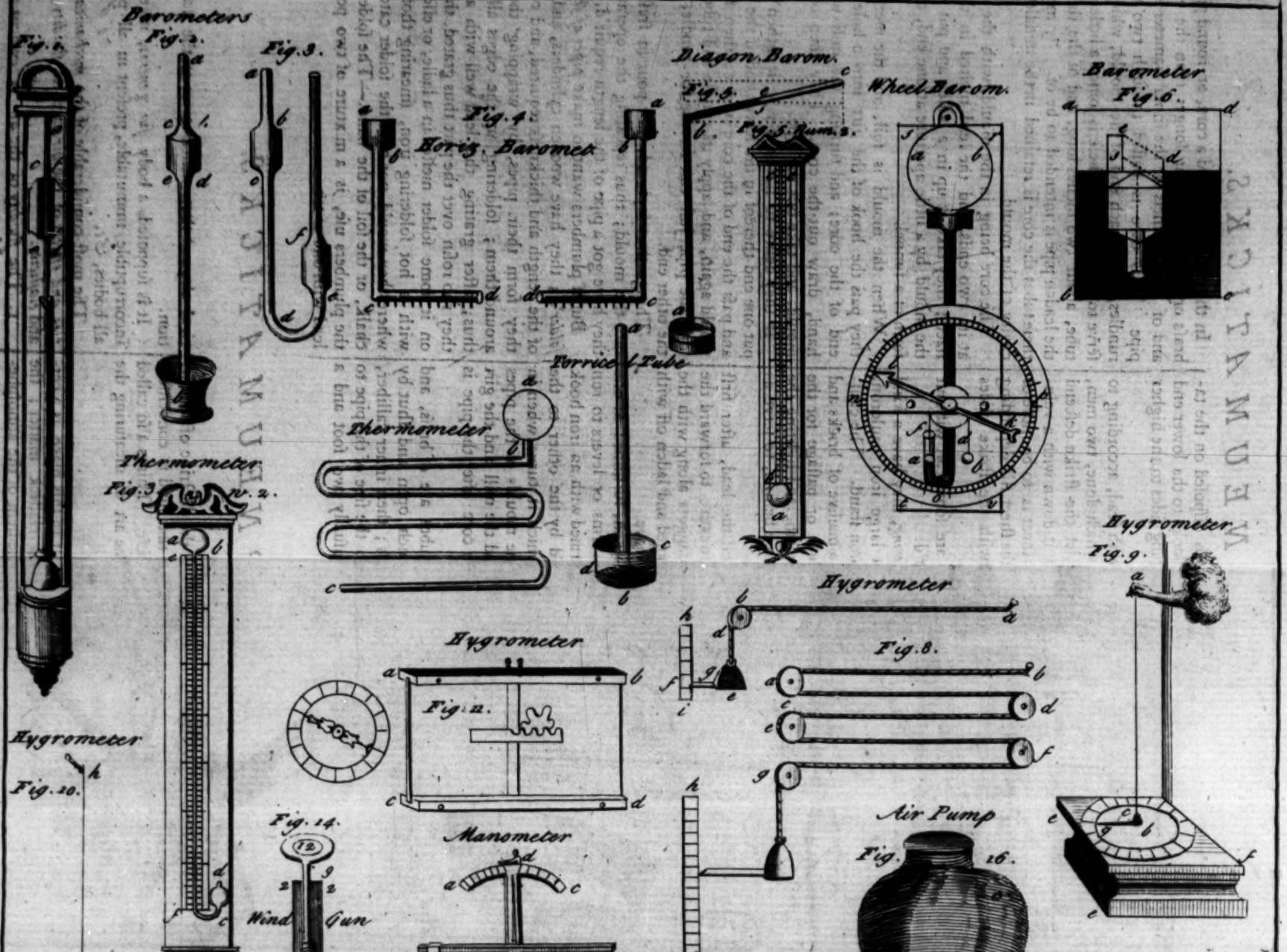
To *caſt thin ſheets of lead*; the table or mould is of a length at diſcretion, only edged on one ſide. Inſtead of ſand they cover it with a piece of woollen ſtuff, nailed down at the two ends to keep it tight; and over this lay a very fine linen cloth. The feet of the table are uneven, ſo that it does not ſtand horizontal, but moderately inclined.

Gread regard is had to the lead while melting, that it has the juſt degree of heat, ſo as it may run well, and yet not burn the linen. This they judge of by a piece of paper; for if the paper takes fire in the liquid lead, it is too hot; and if it be not ſhrunk and ſcorched a little, it is not hot enough.

Being then in its juſt degree, they have a ſtrike, but different from that deſcribed in the former article; as ſerving both for peel and ſtrike, to contain and to conduct the liquid lead. It is, in effect, a wooden caſe without any bottom, only cloſed on three ſides. It is pretty high behind; but the two ſides, like two acute angles, ſtill diminiſh to the tip, from the place where they are joined to the third or middle piece, where they are of the ſame height therewith, *viz.* 7 or 8 inches high. The width of the middle makes that of the ſtrike, which again makes that of the ſheet to be caſt.

The ſtrike is placed a-top of the table, which is before cover'd in that part, with a paſte-board, which ſerves as a bottom to the caſe, and prevents the linen from being burnt, while the liquid is pouring

PNEUMATICKS.



Wind Gun

Areometer

Windmill

Fig. 15.

Anemometer

Fig. 17.

Hygrometer

Fig. 12.

Freezing

Areometer

Fig. 21.

Barom.

pouring in. The ſtrike is ſo diſpoſed on the table, as that the higheſt part looks to the lower end of the table, and the two ſloping ſides to the higher end.

The ſtrike is now filled with lead, according to the quantity to be uſed: which done, two men, one at each ſide the table, let the ſtrike deſcend down the table, or elſe draw it down with a velocity greater or leſs, as the ſheet is to be more or leſs thick; the thickneſs of the ſheet ſtill depending on the promptitude wherewith the ſtrike ſlides down the inclining mould.

As to *pipes of lead*, there are ſome caſt without ſoldering; and others ſolder'd.

To *caſt pipes without ſoldering*, they have a kind of furnace, conſiſting of a large iron cauldron, ſupported on a pretty high iron ſtand. The cauldron is encompaſſed with a maſſive of bricks and loam; only leaving a mouth or paſſage for the conveyance of wood underneath, and lighting the fire, and another little aperture behind, to ſerve as a vent-hole.

In this furnace they melt the lead, after firſt heating it with a fire underneath: to forward the fuſion, they put in burning faggots along with the metal. The metal is ſkimmed and laden off with the inſtruments mentioned above.

Near the furnace is a bench, furniſhed at one end with a little mill, with arms or levers to run it withal. A ſtrong girt, armed with an iron hook at one extremity, is faſten'd by the other to the axis of the mill, around which it turns when in motion. On this bench the moulds of the pipes are placed horizontally, and the mill and the girt ſerve to draw out the iron core after the pipe is caſt.

The moulds of theſe tubes are of braſs, and conſiſt of two pieces, which open and ſhut by means of hooks and hinges; their inner calliber, or diameter, is according to the ſize of the pipe to be made; their length is uſually two foot and a half.

In the middle is placed a core, or round piece of braſs or iron, ſomewhat longer than the mould, and of the thickneſs or the inner diameter of the pipe. This core is paſſed through two copper rundles, one at each end of the mould, which they ſerve to cloſe; and to theſe is joined a little copper tube, about two inches long, and of the thickneſs the leaden pipe is intended to be of. By means of theſe tubes the core is retained in the middle of the cavity of the mould.

The core being in the mould, with the rundles at its two ends, and the lead melted in the furnace; they take it up in a ladle, and put it into the mould, by a little aperture at one end, made in form of a funnel.

When the mould is full, and the metal cold, they paſs the hook of the girt into a hole at the end of the core; and turning the mill with the hand, draw out the core. They then open the mould, and take out the pipe.

If they deſire to have the pipe lengthen'd, they put one end thereof in the lower end of the mould, and paſs the end of the core into it; then ſhut the mould again, and apply its rundle and tube as before, the pipe juſt caſt ſerving for rundle, *&c.* at the other end.

Things thus replaced, they pour in freſh metal into the mould; thus repeating the operation till they have got a pipe of the length requir'd.

But if plumbers want to make *pipes of ſheet-lead ſolder'd*; they have wooden cylinders, and rollers of the length and thickneſs required, and on theſe they form their pipes, by wrapping the ſheet around them; ſoldering up the edges all along, thus; after grating the lead well with a grater, they rub roſin over the part thus grated, then pour on it ſome ſolder melted in a ladle, or elſe melt it with a hot ſoldering iron, ſmearing thoſe parts where they would not have the ſolder catch, with chalk, or the ſoil of the hand.—The ſolder which the plumbers uſe, is a mixture of two pounds of lead with one of tin.

PNEUMATICKS.

PNEUMATICKS, is the doctrine of the air, or the laws wherein that fluid is condenſed, rarefied, gravitated, *&c.* This is alſo called by *Wolfius*, *aerometry*, or the art of meaſuring the air.

The AIR, as I conſider it in this place, is a certain ſubtile homogeneous elaſtick matter; the baſis and fundamental ingredient of the atmoſpherical air, and that, which gives it the denomination.

It is ſuppoſed a body *ſui generis*, ingenerable, incorruptible, immutable, preſent in all places, in all bodies, *&c.*

The moſt conſiderable of the *mechanical properties and effects* of the *air*, are its *fluidity*, *weight*, and *elaſticity*.

1. The *fluidity* of the *air* is evident from the

paſſage it affords to bodies through it; as in the propagation of ſounds, ſmells, and other effluvia.

The cauſe of this fluidity of the *air*, is attributed by ſome very modern philoſophers to the fire intermixed therewith; without which they imagine the atmoſphere would harden into a ſolid, impenetrable maſs. And hence the greater the degree of fire therein, the more fluid, moveable, and pervious the air: and thus as the degree of fire is continually varying, according to the circumſtances and poſition of the heavenly bodies; the *air* is kept by a continual reciprocation. Hence, in good meaſure, it is, that on the tops of the higher mountains, the ſenſes of ſmelling, hearing, *&c.* are found very feeble.

2. That the *air* is heavy, follows from its being a body.

We can actually weigh *air*; for a veſſel, full even of common *air*, by a very nice ballance, is found to weigh more than when the *air* is exhauſted; and this effect is proportionably more ſenſible, if the ſame veſſel be weighed full of condenſed *air*, in a receiver void of *air*.

The weight of *air* is continually varying, according to the different degree of heat and cold.—*Ricciolus* eſtimates its weight to that of water, to be as 1 to 1000; *Merſennus*, as 1 to 1300, or 1 to 1356; *Lana*, as 1 to 640; *Galileo* only makes it as 1 to 400. The ingenious Mr. *Boyle*, by a more accurate experiment, found it about *London*, as 1 to 938: and thinks, all things conſider'd, the proportion of 1 to 1000 may be taken at a medium.

By experiments made ſince before the Royal Society, the proportion of *air* to water was firſt found as 1 to 840; then, as 1 to 852; and a third time, as 1 to 860. By a very ſimple and accurate experiment of the late Mr. *Hawkſbee*, the proportion was ſettled, as 1 to 885.

The difference of the *air*'s weight at different times, is meaſured by the different height to which the mercury is raiſed in the barometer; and the greateſt variation of the height of the mercury being three inches, a column of *air* of any aſſignable baſe, equal to the weight of a cylinder of mercury of the ſame baſe, and of the altitude of three inches, will be taken off from the preſſure upon a body of an equal baſe, at ſuch time as the mercury is three inches lower in the barometer; ſo that every inch ſquare of the ſurface of our bodies, is preſſed upon at one time more than another, by a weight of *air*, equal to the weight of three cubical inches of mercury. Now a cubical foot of water being ſeventy-ſix pounds; a cubical foot of mercury is 1664 pounds = 102144 drachms; and as 102144 drachms is to a cubical foot, or, which is allone, 1728 cubical inches, ſo is 59 $\frac{102}{171}$ drachms, to one cubical inch. So that a cubical inch of mercury being very near = 59 drachms; and there being 144 ſquare inches in a foot ſquare, therefore a maſs of mercury of a foot ſquare = 144 ſquare inches, and if three inches high, muſt contain 432 cubical inches of mercury, which + 59 (the number of drachms in a cubical inch of mercury) makes 25488 drachms. And this weight was a foot ſquare of the ſurface of our bodies, ſuſtained at one time more than at another.

Suppoſe, again, the ſuperficies of an human body = 15 feet ſquare; then would the body ſuſtain at one time more than at another, a weight = 15 + 25488 = 382230 drachms (= 47790 ounces) = 3890$\frac{1}{2}$ pounds troy.

Hence it is ſo far from being a wonder, that we ſometimes ſuffer in our health, by a change of weather; that it is the greateſt wonder we do not always do ſo.—For when we conſider, that our bodies are ſometimes preſſed upon by near a ton and a half weight more than at another, and that this variation is often very ſudden; it is ſurprizing that every ſuch change does not entirely break the frame of our bodies to pieces.

To meaſure the weight of the *air* or atmoſphere, and the variations therein, in order chiefly to determine the changes of the weather, an inſtrument was invented, called *barometer*, from βαρος, weight; and μετρον, meaſure; the deſcription and phænomena thereof come very a-propos under this article of the weight of the air.

The Barometer is founded on the torricellian experiment, as it is called from its inventor *Torricelli*, which is no more than a glaſs tube filled with mercury, hermetically ſealed at one end; the other open, and immerged in a baſon of ſtagnant mercury. Now as the weight of the atmoſphere diminiſhes, the mercury in the tube will here deſcend; on the contrary, as it increaſes, the mercury will again aſcend: the column of mercury ſuſpended in the tube being always equal to the weight of the incumbent atmoſphere.

There are ſeveral kinds of *barometers*, viz. the *common*, *horizontal*, *diagonal*, *wheel*, *marine*, *ſtatical*, and *portable barometers*.

The conſtruction of a *common barometer*, is as follows.—A glaſs tube A B (*Fig.* 1. *pneumatick table*) hermetically ſealed in A, having its diameter about $\frac{1}{10}$ of an inch, and its length at leaſt thirty-one inches, is filled with mercury ſo juſtly, at not to have any air over it, nor any bubbles adhering to the ſides of the tube; which is beſt done by means of a glaſs funnel, with a capillary tube. The orifice of the tube filled after this manner, ſo

as

as to overflow, is closely pressed by the finger, so as to exclude any air between it and the mercury, and thus immerged in a wooden vessel of a convenient diameter; so however, as not to touch the bottom: at the distance of twenty-eight inches from the distance of the mercury, are fixed two plates, C E and D F, divided into three inches, and these again subdivided into any number of smaller parts. Lastly, the tube is enclosed in a wooden frame to prevent its being broke; and the bason, though open to the air secured from dust, and the *barometer* is compleat.

Many attempts have been made to render the changes of the barometer more sensible, and so to measure the atmosphere more accurately; which has given rise to the following *barometers* of different structure.

Des Cartes, and after him *Huygens*, used a tube A B, (*Fig* 2.) having a cylindrick vessel C D; one half of which vessel, together with the upper part of the tube, were filled with water; the other half of the vessel, and the lower part of the tube with mercury. But here, though the column suspended was longer, and consequently the variation greater, yet the air imprisoned in the water getting loose by degrees, filled the wide space in the top, and so ruined the machine.

Huygens then bethought himself of placing the mercury at top, and the water at bottom, in the manner following: A D G (*Fig.* 3.) is a bent tube hermetically sealed in A, and open in G; the cylindrick vessels B C and F E are equal, and about twenty nine inches a-part; the diameter of the tube is about a line, that of each vessel fifteen lines, and the depth of the vessels about ten; the tube is filled with mercury (the common *barometer* standing about twenty-nine inches) which will be suspended between the middle of the vessel F E, and that of the vessel B C; the remaining space to A being void both of mercury and air. Lastly, common water, tinged with a sixth part of aqua regis, to prevent its freezing, is poured into the tube F G, till it rises a foot above the murcury in D F.

When then the mercury rising above the level of that contained in F E, through the tube A D, becomes a ballance to the weight of the atmosphere; as the atmosphere increases, the column of mercury will increase, consequently the water will descend; as the atmosphere again grows lighter, the column of mercury will descend, and the water ascend. This *barometer* therefore, which is the same with that of Dr. *Hook*, will discover much minuter alterations in the air than the common one: for, instead of two inches, the fluid will here vary two feet; and by enlarging the diameters of the cylinders, that variation may be still increased: but it has this inconvenience, that the water will evaporate, and so render the alterations precarious; though the evaporation be in some measure prevented by a drop of oil of sweet almonds swimming a-top.

On account of this defect, others have had recourse to a *horizontal* or *rectangular barometer* A B C D (*Fig.* 4.) the tube whereof is bent in form of a square B C D, a-top of its perpendicular leg it is joined to a vessel or cistern A B; and its variation accounted on the horizontal leg C D.

Now here the interval or space of variation, may be made of any extent at pleasure, and so the minutest change in the air become sensible. For the diameter of the tube C D being given, it is easy to find the diameter of the vessel A B, so as that the scale of descent in the tube D C shall have any given proportion to the scale of ascent, in the vessel A B; the rule being, that the diameter of the vessel is to that of the tube in a subduplicate reciprocal ratio of their scales.

The diameters then of C D and A B being given, together with the scale, or ascent of the mercury in the vessel, the scale of mercury in the tube is found thus: as the square of the diameter of the tube, is to the square of the diameter of the vessel, so reciprocally is the scale of mercury in the vessel, to the scale of mercury in the tube.

This last however, with its virtues, has great defects.

Some therefore prefer the *diagonal barometer*, where the space of variation is considerably larger than in the common one, and yet the rise and fall more regular than in the others. Its foundation is this, that in a *torricellian* tube B C (*Fig.* 5.) inclined at any angle to the horizon, the cylinder of mercury, equivalent to the weight of the atmosphere, is to a cylinder of mercury, equivalent to the same placed in a vertical tube, as the length of the tube B C, to the perpendicular height D C. Hence if the height D C be subtriple, subquadruple, *&c.* of the length of the tube, the changes in the diagonal barometer will be double, or triple, *&c.* of the changes in the common barometer.—This barometer will scarce allow its tube to be inclined to the horizon, at a less angle than 45 degrees, without undergoing the inconveniency of the horizontal one.

The *wheel barometer* is a contrivance of Dr. *Hook*, to make the alterations in the air more sensible; the foundation of this is the common vertical barometer, with the addition of a couple of weights A and B (*Fig.* 5.) hanging in a pulley, the one playing at liberty in the air, the other resting on the surface of the mercury in the tube, and rising and falling with it. Thus is the motion of the

mercury communicated, by means of the pulley, to an index which turns around a graduated circle; and thus the three inches of vertical aſcent, are here improved to five or ſix, or more, at pleaſure.—But the friction of the parts, in the pully and index, is ſo conſiderable, that unleſs the machine be made with a great deal of accuracy, it does not anſwer.

The *pendant barometer* is a machine rather pretty and curious, than uſeful. It conſiſts of a conical tube, placed vertically; its upper and ſmaller extreme hermetically ſealed; it has no veſſel or ciſtern, its conical figure ſupplying that defect: for when filled, like the reſt, there will be as much mercury ſuſtained, as is equivalent to the weight of of the atmoſphere; and as that varies, the ſame mercury takes up a different part of the tube, and ſo becomes of a different weight.

The *marine barometer* is likewiſe a contrivance of Dr. *Hook*, to be uſed at ſea, where the motion of the waves render the others impracticable. It is nothing more than a double thermometer, or a couple of tubes half filled with ſpirit of wine; the one hermetically ſealed at both ends with a quantity of common air incloſed; the other ſealed at one end, and open at the other.

This inſtrument is ſaid to be of good uſe in giving notice of all bad weather at ſea, alſo of variable winds.

The *ſtatical barometer*, or *baroſcope*, uſed by Mr. *Boyle*, *Otto de Guerick*, &c. is fallacious and liable to be acted on by a double cauſe. It conſiſts of a large glaſs bubble, ballanced by a braſs weight, in a nice pair of ſcales: for theſe two bodies being of equal gravity, but unequal bulk, if the medium in which they equiponderate be changed, there will follow a change of their weight; ſo that if the air grows heavier, the greater body being lighter in ſpecie, will loſe more of its weight than the leſſer, and more compact; but if the medium grows lighter, then the bigger body will outweigh the leſs.

The moſt accurate barometer yet invented, ſeems to be that of Mr. *Gaſwell*; the ſtructure whereof he deſcribes as follows: ſuppoſe A B C D (*Fig.* 6,) a bucket of water, wherein is the barometer, *x*, *r*, *s*, *z*, *y*, *o*, *f*, *m*, conſiſting of a body *x r f m*, and a tube *s z y o*, the body and tube are both concave cylinders made of tin, or rather glaſs, and communicating with each other. The bottom of the tube *z y*, has a lead weight to ſink it, ſo as the top of the body may juſt ſwim even with the ſurface of the water, by the addition of ſome grain weights a top. The water, when the inſtrument is forced with its mouth downwards, gets up into the tube to the height *y o*. There is added on the top a ſmall concave cylinder, which we call the pipe, to diſtinguiſh it from the other at bottom, which we call the tube: this pipe is to ſuſtain the inſtrument from ſinking to the bottom. In *d* is a wire, in S, *d e*, two threads oblique to the ſurface of the water, performing the office of diagonals. Now, while the inſtrument ſinks more or leſs, by the alteration of the gravity of the air; there, where the ſurface of the water cuts the thread, is formed a ſmall bubble, which aſcends up the thread, as the mercury of the common barometer aſcends, and *vice verſa*.

This inſtrument, as appears from a calculation which the author gives, ſhews the alterations in the air more accurately than the common barometer, by 1200 times. He obſerves, that the bubble is ſeldom known to ſtand ſtill a minute; that a ſmall blaſt of wind that cannot be heard in a chamber, will make it ſink ſenſibly; that a cloud always makes it deſcend, *&c.*

The phænomena of the *barometer* are various; and the cauſes aſſigned for them by ſeveral authors, widely different.

Mr. *Boyle* obſerves, that it is exceedingly difficult to form any general rules about the riſe or fall thereof. Even that which ſeems to hold moſt univerſally, *viz.* that when high winds blow, the mercury is the lower, ſometimes fails.

Dr. *Halley* gives us the following obſervations: that in calm weather, when the air is inclined to rain, the mercury is commonly low; in ſerene, good ſettled weather, high.

That on good winds, though accompanied with rain, the mercury is the loweſt of all, with regard to the point of the compaſs the wind blows on. That *cæteris paribus*, the greateſt height of the mercury, are on eaſterly and north-eaſterly winds. That after great ſtorms of wind, when the mercury has been low, it riſes again very faſt.

That in calm froſty weather it ſtands high.

That the more northerly places find greater alterations than the more ſouthern; and that within the tropicks, and near them, there is little or no variation of the height of the mercury at all.

Some of the moſt modern authors ſpeak on the *cauſes of the phænomena of the barometer*, in the following manner.—Suppoſe, ſay they, any number of watery veſicles floating in any part of the atmoſphere over any determinate portion of the globe, for inſtance, over A B (*Fig.* 21.) if the upper veſicles be condenſed by the cold of the ſuperior regions, their ſpecifick gravity will be increaſed, and they will deſcend; the horizontal claſs, 1, *v. gr.* to 2, 2 to 3, *&c.* where meeting with other veſicles not yet precipitated, they will coaleſce or run into larger veſicles, by the known laws of attraction.

tion. Or if we rather chuſe to have the wind act, let it drive either horizontally or obliquely; in the former caſe the veſicles, claſs 8, will be driven againſt 9; thoſe againſt 10, &c. or the oblique claſs A 7, driven againſt 5, 8 againſt 4, &c. by which means likewiſe will the particles coaleſce, and form new and large veſicles, as before; ſo that their number, which before was ſuppoſed a million, will now be reduced, *v. gr.* to a hundred thouſand.

III. *Elaſticity.*—A power of yielding to an impreſſion, by contracting its dimenſions; and upon removing or diminiſhing the impulſive cauſe, returning to its former ſpace or figure. This elaſtick force is accounted the diſtinguiſhing property of the air; the other properties hitherto enumerated, being common to it with other fluids.

On this property of *elaſticity*, the ſtructure, and office of the *air-pump* depends.

The invention of this noble inſtrument is aſcribed to *Otto de Guerick*, conſul of *Magdebourg*, in the year 1654.

The *air-pump*, as it is now made among us with all its advantages (*Fig.* 16.) conſiſts of two brazen barrels or cylinders repreſented by *a a a a*; which communicates with each other by a canal paſſing between them at *d d*, and with a receiver *o o o*, by means of a hollow wire *b b*, one end whereof opens into the canal of communication, and the other into a like canal *n n*, which penetrating the plate *i i i i*, opens into the receiver.

Within the cylinder are two emboli, or ſuckers, made of braſs, and fitted with cork and leather to the cavities of the barrels, ſo as exactly to fill the ſame; each being furniſhed with its valve, and terminating at top in a rack *c c*, by which it is to be worked.

At the bottom of either barrel is another valve; by which the air may paſs out of the communicating canal *a d*, and conſequently out of the hollow wire, and the receiver itſelf, into the cylinder below the piſton; from whence by the valves of the piſton it may proceed into the upper ſpace of the cylinder, and thus into the open air.

For the *application* of this mechaniſm, the winch *b b* being turned upwards and downwards, its ſpindle *f* catching by its teeth into the racks, will riſe and depreſs the two piſtons alternately. Now, the conſequence of depreſſing a piſton is, that the air before incloſed between it and the bottom of the cylinder, being thus crowded into a leſs compaſs, will, by its elaſtick force, which now exceeds the preſſure of the atmoſphere, puſh up the valve of the piſton, and thus eſcape, till what little remains be of the ſame denſity with the external air incumbent on the valve.

This done, and the ſame piſton being again raiſed in its turn, from the bottom of the cylinder to the top; the little air before left will of neceſſity expand itſelf, ſo as to poſſeſs the whole ſpace of the cylinder thus deſerted by the piſton: upon which its force or preſſure upon the valve at the bottom of the cylinder being now inconſiderable; the other denſer air of the receiver, hollow wire, and canal of communication, by their ſuperior elaſtick force, will lift up the valve, and thus paſs into the cylinder of rarefied air, till both be of the ſame degree of denſity.

And thus is the air in the receiver diminiſhed at each elevation of the piſton, by the quantity of a cylinder-full; abating for what little remained between the depreſſed piſton and the bottom. So that by thus repeating the operation again and again; the air in the receiver is at length rarefied to ſuch a degree, that its denſity does not exceed the thin air remaining in the cylinder when the piſton is raiſed: which done, the effect of the *air-pump* is at an end; the valve cannot now be opened, or if it could, no air would paſs it; there being a juſt equilibrium between the air on each ſide.

To judge of the degree of exhauſtion, there is added a gage *l l*, conſiſting of a tube, whoſe upper orifice communicates with the receiver; the lower being immerged in a baſon of mercury *m m*. Hence the *air* in the tube rarefying as faſt as that in the receiver; in proportion as the exhauſtion advances, the mercury will be raiſed by the preſſure of the column of external *air*, prevailing over that of the column of *air* included, till the column of *air*, and mercury together, become a ballance to that of the external *air*. When the mercury is thus riſen to the ſame height as it ſtands in the barometer, which is indicated by the ſcale of inches added to the gage; the inſtrument is a juſt torricellian tube; and the vacuum, ſay thoſe who admit ſuch things, may be concluded to be as perfect as that in the upper end of the barometer.

To let *air* again into the exhauſted receiver, the cock *n* is to be turned; which makes a communication with the external *air*; upon which the *air* ruſhing impetuouſly in, the mercury in the gage immediately ſubſides into the baſon.

To the *air-pump* belongs a large apparatus of other veſſels, accommodated to the divers kinds of experiments.

As to the effects and phænomena of the *air-pump*; it is pretended by the aſſerters of the *vacuum Boyleanum*, that we arrive at it by means of the *air-pump*.——Thus any thing put in a receiver ſo exhauſted, is ſaid to be put *in vacuo*; and ſome of the principal phænomena thereof to be, that the heavieſt and lighteſt bodies as a guinea, and a feather,

ther, falls here with equal velocity.—That fruits, as grapes, cherries, apples, *&c.* kept for any time *in vacuo*, retain their nature, freſhneſs, colour, *&c.* and thoſe wither'd in the open air, recover their plumpneſs *in vacuo*.——All light, and fire becomes immediately extinct *in vacuo*.——The coalition of flint and ſteel *in vacuo*, produces no ſparks.——No ſound is heard, even from a bell rung *in vacuo*.——A ſquare viol, full of common air, well cloſed, breaks *in vacuo*; a round one does not.——A bladder half full of air will heave up forty pounds weight *in vacuo*.——Cats, and moſt other animals readily expire *in vacuo*.

The *air-pump* can never produce a preciſe vacuum, if even ſuch a thing was poſſible; as is evident from its ſtructure, and the manner of its working: in effect, every exſuction only takes a part of the air: ſo that there will ſtill be ſome left after any infinite number of exſuctions.——Add, that the *air-pump* has no longer any effect, than while the ſpring of the air remaining in the receiver, is able to lift up the valves: when the rarefaction is come to that degree, you can come no nearer to a vacuum.

The weight or preſſure of the air has no dependance on its elaſticity; but would be the ſame whether the air had ſuch property or not.—But the air, in being elaſtick, is neceſſarily affected by the preſſure, which reduces it into ſuch a ſpace, as that the elaſticity, which re-acts againſt the compreſſing weight, is equal to that weight.

In effect, the law of this elaſticity, is, that it increaſes as the denſity of the air increaſes; and the denſity increaſes, as the force increaſes wherewith it is preſſed. Now there muſt neceſſarily be a ballance between the action and re-action, *i. e.* the gravity of the air which tends to compreſs it, and the elaſticity of the air, which endeavours to expand it, muſt be equal.

Hence the elaſticity increaſing, or diminiſhing univerſally as the denſity increaſes or diminiſhes, *i. e.* as the diſtance between the particles diminiſhes or increaſes; it is no matter whether the air be compreſſed and retained in ſuch ſpace by the weight of the atmoſphere, or by any other means: it muſt endeavour in either caſe, to expand with the ſame force. And hence, if air near the earth be put up in a veſſel, ſo as to cut off all communication with the external air; the preſſure of the incloſed air will be equal to the weight of the atmoſphere. Accordingly we find mercury ſuſtained to the ſame height, by the elaſtick force of air, incloſed in a glaſs veſſel, as by the whole atmoſpherical preſſure.

Hence the ſtructure of the WIND-GUN, which is a machine ſerving to explode bullets, and other ſhot with great violence, by the force of the air.

There are *wind-guns* of divers contrivances; the moſt eaſy and portable one, and the moſt in uſe is repreſented (*tab. pneum.* Fig. 14.) it conſiſts of a round melted tube 3, 3, open at the end *c*, *c*, and exactly ſtopped at the other end *a*, like the barrel of other guns: 1, 1, 1, 1, is another larger metal tube, wherein the former is diſpoſed, ſo as to leave a ſpace between them 4, 4, wherein air may be incloſed.——The two tubes are joined together at the common aperture *c c*, by a circular plate exactly ſolder'd to both, ſo as to prevent the air from eſcaping out of the ſpace 4, 4, *&c.* At 8 is a ſpring valve, which opening inwardly, let the air paſs through from 2 into the ſpace 1, but prevents its return from 1 to 2. Near the cloſe end of the inner tube are two holes 6 and 5; by the firſt, the ſpace 1, and the inner tube communicate, ſo that the air would paſs out of that into this, but that the paſſage is ſtopped by a valve opening outwardly; by the latter there is a communication between the open air, the ſpace 4, and the inner barrel; only the air pent up in the ſpace, cannot eſcape at this hole, by reaſon of a little tube exactly ſolder'd to both barrels, which ſtops the communication: nor can air eſcape out of the inner barrel through this little tube, by reaſon of a little moveable pin, which exactly fills the cavity of the tube.

Laſtly, the part 2, 2, 2, 2, repreſents the body of a ſyringe, or ſucking pump; by which as much air as poſſible is to be intruded into the ſpace 4, 4, *&c.* After which a bullet being put into a cavity of the inner barrel, as high as the little tube 5, the gun is charged.

Now to diſcharge it, the little valve 6, is puſhed up by means of the pin that plays in the little tube 5. Upon this, the compreſſed air in the cavity of the outer barrel 4, ruſhing through the hole 6, into the cavity of the inner barrel, expels the bullet with a vaſt force, ſufficient to penetrate a thick board.

To give the machine a greater reſemblance of a fire-arm, the part 2, 2, 2, 2, is uſually faſhioned like the but-end of a muſket; and on the part 2, 8, 2, 8, is fitted a lock; by turning the trigger of which, the pin 5 is made to puſh back the valve, and ſo diſcharge the piece. By the lock it is contrived, that either the whole charge of air may be ſpent by exploſion, or only part of it, and the reſt reſerved for freſh bullets. By this piece of mechaniſm we can have half a dozen good effective ſhoots, with one charge of air.

The dilatation of the air by reaſon of its elaſtick force, is found to be very ſurprizing.

On this depends the ſtructure and uſe of the *monometer*, which is an inſtrument to ſhew or meaſure the alterations in the rarity or denſity of the air.

The

The MONOMETER differs from the *barometer*, in that the latter only measures the weight of the atmosphere, or of the column of air over it; but the former the denſity of the air in which it is found: which denſity depends not only on the weight of the atmoſphere, but on the action of heat and cold, *&c.*

M. *Montons*, and others, take the rarefaction of *air* to ariſe wholly from the fire contained in it; and hence, by increaſing the degree of heat, the degree of rarefaction may be carried ſtill further than its ſpontaneous dilatation.

On this principle depends the ſtructure and office of the *thermometer*, which is an inſtrument ſhewing, or rather meaſuring the increaſe and decreaſe of the cold and heat of the *air*.

THRMOMETER, and *thermoſcope*, are ordinarily accounted the ſame thing; *Wolfius*, however, makes a difference; but ſhews withal, that what we call *thermometers* are, in reality, no more than *thermoſcopes*.

There are various kinds of *thermometers*, the conſtructions, defects, theory, *&c.* whereof are as follow.

For *the conſtruction of a thermometer depending on the rarefaction of the air*; in a tube BC (*Fig.* 3. n. 2.) to which is faſtened a glaſs ball AB, is put a quantity of common water mixed with aqua regia, to prevent its freezing; and the mixture tinged with a ſolution of vitriol, to give it a greeneſs. In filling the tube, care is taken that there be ſo much *air* left in the ball and the tube, as that when at its greateſt condenſation in the middle of winter, it may juſt fill the ball; and yet in its greateſt rarefaction in ſummer, may not drive all the liquor out of the tube. To the other extreme of the tube is faſtened another glaſs ball CD, open to the *air* at D: on each ſide the tube is applied the ſcale EF, divided into any number of equal parts.

Now, as the ambient *air* becomes warmer, the *air* in the ball and the top of the tube expanding, will drive the liquor into the lower ball; and conſequently its ſurface will deſcend: on the contrary, as the ambient air grows colder, that in the ball becoming condenſed, the liquor will aſcend.

For the *conſtruction of a mercurial thermometer*; in the ſame manner, and with the ſame caution as before, put a little quantity of mercury, not exceeding the bigneſs of a pea, into a tube BC (*Fig.* 4. n. 2.) thus bent in wreaths, that taking up the leſs height, it may be the more manageable, and leſs liable to harm; divide this tube into any number of equal parts to ſerve for a ſcale.

Here the approaches of the mercury towards the ball A will ſhew the increaſes of the degrees of heat. The reaſon is the ſame as in the former.

The defect of both theſe inſtruments conſiſts in this, that they are liable to be acted on by a double cauſe: for, not only a decreaſe of heat, but alſo an increaſe of weight of the atmoſphere will make the liquor riſe in the one, and the mercury in the other; and on the contrary, either an increaſe of heat, or decreaſe of weight in the atmoſphere, will make it deſcend.

For the *conſtruction of the florentine, or common thermometer*; the academiſts *del cimento* conſidering the inconveniencies of the *thermometers* juſt deſcribed, attempted another, that ſhould meaſure heat and cold by the rarefaction and condenſation of the ſpirit of wine, though thoſe be vaſtly leſs than of *air*; and conſequently the alterations in the degrees of heat like to be much ſenſible.

The ſtructure of their *thermometer* is this: on ſome little pieces of turmerick is poured a quantity of rectified ſpirit of wine, which hereby receives a red tincture; this done, the ſpirit of wine is filtrated again and again through a brown paper, that the coarſe particles of the root may be ſeparated therefrom. With the ſpirits thus tinged and prepared they fill a glaſs ball AB (*Fig.* 5. n. 2) and a tube BC; and that all the ſpirit may not deſcend in the winter into the ball, it is convenient to put the ball into a lump of ſnow, mixed with ſalt; or, if the inſtrument be to be made in ſummer, into ſpring water, impregnated with ſaltpetre, that the condenſed ſpirit may ſhew how far it will retire in the extremeſt cold.

If it riſe to too great a height from the ball, part of it is to be taken out; and that the tube may not be made longer than need, it is convenient to immerge the ball, filled with its ſpirit, in boiling water, and to mark the furtheſt point, to which the ſpirit then riſes.

At this point the tube is to be hermetically ſealed by the flame of a lamp: and at the ſides is to be added a ſcale, as in the former *thermometer*.

Now, ſpirit of wine rarefying and condenſing very conſiderably, as the heat of the ambient *air* increaſes the ſpirit will dilate, and conſeqently will aſcend into the tube; and as the heat decreaſes the ſpirit will deſcend: and the degree or quantity of aſcent and deſcent will be ſeen in the ſcale. Yet as the ratio of yeſterday's heat to to-day's is not hereby diſcovered, this inſtrumet is not ſtrictly a *thermometer*, no more than the former.

M. *de Reamure* has contrived a new *thermometer*, wherein the inconveniencies of others are remedied.

On the *elaſticity* of the air, depends alſo the *height of the atmoſphere*.

Air not only acts by its common properties of *gravity*, and *elasticity*, but there are numerous other effects arising from the peculiar ingredients whereof it consists.

Thus, 1. It not only dissolves and attenuates bodies by its pressure and attrition, but as a chaos containing all kinds of menstruums, and consequently having wherewithal to dissolve all kinds of bodies.

It is known, that iron and copper readily dissolve, and become rusty in air, unless well defended with oil. *Boerhaave* assures us, he has seen pillars of iron so reduced by air, that one might crumble them to dust between the fingers; and for copper, it is converted by the air into a substance much like the verdigrease producted by vinegar.

Mr. *Boyle* relates, that in the southern *English* colonies, the great guns rust so fast, that after a few years lying in the air, large cakes of crocus martis may be easily beat off them. *Acosta* adds, that in *Peru* the air dissolves lead, and considerably increases its weight.—Yet gold is generally esteemed indissoluble by air, being never found to contract rust, though exposed ever so long. The reason whereof is, that sea salt, which is the only menstruum capable of acting on gold, being very difficult to volatilize; there is but a small proportion of it in the atmosphere. In the chymist's laboratory, where aqua regia is preparing; the air becoming impregnated with an unusual quantity of this salt, gold contracts a rust like all other bodies.

Stones, also, undergo the common fate of metals —Thus *purbeck* stone, whereof *Salisbury* cathedral is built, is observed gradually to become softer, and moulder away in the air, and the like Mr. *Boyle* relates of *Blackinton* stone.——He adds, that air may have a notable operation on vitriol, even when a strong fire could act no further on it. The same author has even found the fumes of a sharp liquor to work more suddenly and manifestly on a certain metal, when sustained in the air, than the menstruum itself did, which emitted fumes on those parts of the metal it cover'd.

2. Air volatilizes fixed bodies. Thus sea salt being calcined and fused by the fire, and when fused, exposed to the air to liquify; when liquified set to dry again, then fused again; and, the operation thus repeated, will by degrees be almost wholly evaporated; nothing remaining but a little earth behind.

Helmont mentions it as a mighty arcanum in chymistry, to render fixed salt of tartar volatile: but the thing is easily effected by air alone; for if this salt be exposed to the air, in a place replete with acid vapours, the salt draws the acid to itself, and when saturated therewith is volatile.

3. Air also fixes volatile bodies. Thus, tho' nitre or aqua fortis readily evaporate by the fire; yet, if there be any putrified urine near the place, the volatile spirit will be fixed, and fall down in form of aqua secunda.

4. Add that air brings many quiescent bodies into action, *i. e.* excites their latent powers. Thus, if an acid vapour be diffused through the air, all the bodies whereof, that is a proper menstruum, being dissolved thereby, are brought into a state proper for action.

In chymistry, not only the presence or absence of the air, but even its being barely open or inclosed, is of great consequence. Thus camphire fired in a close vessel runs wholly into salts; whereas, if during the process the cover be removed, and a candle applied, the whole flies off in fume. So to make sulphur inflammable, it requires a free air: in a close cucurbite it may be sublimated a thousand times without kindling. Sulphur being put under a glass bell, and a fire applied, rises into spirit of sulphur *per campanam*. But if there be the least chink, whereby the included air communicates with the atmosphere, it immediately kindles. So an ounce of charcoal, inclosed in a crucible well luted, will remain without loss for fourteen days in the intensest heat of a melting furnace; though the thousandth part of the fire in an open air, will presently turn in into ashes. *Helmont* adds, that the charcoal remains all that while without any alteration of its black colour; but the minute air being let in, it falls instantly into white ashes. The same holds of the parts of all animals and vegetables, which can only be calcined in open air: in close vessels they never become any other than black coals.

The air is liable to abundance of alterations, not only in respect of its mechanical properties, gravity, density, *&c.* but also in respect of the ingredients it consists of. Thus in places abounding with marcasites, a fretting vitriolick salt is observed to predominate in the air, which rots the hangings, and is often seen lying on the ground in a whitish efflorescence. At *Fahlun* in *Sweden*, noted for copper-mines, the mineral exhalations affect the air so sensibly, that their silver coin is frequently discolour'd in their purses, and the same effluvia change the colour of brass.

The effluvia of animals also have their effect in varying the air; as is evident in contagious diseases, plagues, murrains, and other mortalities which spread by the air.

The *air* is also liable to alterations from the seasons of the year, if the same seed be sown in the same soil, in autumn and spring, and the degree of heat be the same, a very different effect will be found.

Mr. *Boyle* suggests something further on this head, *viz.* that the salts, *&c.* which in a warm state of weather were kept in a fluor, and mixed together, so as to be in a condition to act conjunctly; upon a remission of the warmth, may lose their fluidity

fluidity and motion, ſhoot into cryſtals, and thus ſeparate again.

The height or depth of the *air* makes a further alteration, the exhalations being few of them able to aſcend above the top of high mountains, as appears from thoſe plagues, where the inhabitants of one ſide of a mountain have all periſhed, without the leaſt diſorder on the other ſide.

Nor muſt draught and moiſture be denied their ſhare, in varying the ſtate of the *atmoſphere*. In *Guinea* the heat with the moiſture conduce ſo much putrefaction, that the pureſt white ſugars are often full of maggots; and their drugs ſoon loſe their virtue, and many of them grow verminous.

On this principle depends the ſtructure and office of the HYGROMETER, which is a machine or inſtrument, whereby to meaſure the degrees of dryneſs, or moiſture of the air.

There are divers kinds of *hygrometers*; for whatever body either ſwells or ſhrinks by dryneſs or moiſture, is capable of being formed into an *hygrometer*. Such are wood of moſt kinds, particularly aſh, deal, poplar, *&c.* ſuch alſo is catgut, the beard of a wild cat, *&c.*

The beſt and moſt uſual contrivances for this purpoſe are as follows:

Stretch a hempen cord, or a fiddle-ſtring, as A B C (*Fig.* 7.) along a wall, bringing it over a truckle, or pully B; and to the other extreme D, tie a weight E, into which fit a ſtyle or index F G. On the ſame wall fit a plate of metal H I, divided into any number of equal parts; and the *hygrometer* is compleat.

For it is matter of undoubted obſervation, that moiſture ſenſibly ſhortens the length of cords and ſtrings; and that as the moiſture evaporates, they return to their former length; and the like may be ſaid of a fiddle-ſtring. The weight therefore, in the preſent caſe, upon an increaſe of the moiſture of the *air*, will aſcend; and upon a diminution of the ſame deſcend.

Hence as the index F G will ſhew the ſpaces of aſcent and deſcent; and thoſe ſpaces are equal to the increments and decrements of the length of the cord, or gut, A B D; the inſtrument will diſcover, whether the air be more or leſs humid now than it was another given time.

Or thus:—If a more ſenſible and accurate *hygrometer* be required; ſtrain a whipcord or fiddle-ſtring over ſeveral truckles, or pulleys, A, B, C, D, F, and G (*Fig.* 8.) and proceed with the reſt as in the former example. Nor does it matter whether the ſeveral parts of the cord, A B, B C, C D, D E, E F, and F G, be parallel to the horizon, as expreſſed in the preſent figure, or perpendicular to the ſame.

The advantage of this above the former *hygrometer*, is, that we have a greater length of cord in the ſame compaſs: and the longer the cord, the greater its contraction or dilatation.

Or thus:—Faſten a hempen cord or fiddle-ſtring A B (*Fig.* 9.) to an iron hook; and let the other end B, deſcend upon the middle of an horizontal board or table E F; near B hang a leaden weight of a pound C, and fit an index C G; laſtly, from the center B deſcribe a circle, which divide into any number of equal parts.

Or thus:—Faſten one end of a cord, or fiddle-ſtring H I (*Fig.* 10.) to a hook H; and to the other end faſten a ball K, of a pound weight. Draw two concentrick circles on the ball, and divide them into any number of equal parts. Fit a ſtyle or index N O, into a proper ſupport N, ſo as the extremity O may almoſt touch the diviſions of the ball.

Here the cord or gut twiſting and untwiſting, as in the former caſe, will indicate the change of moiſture, *&c.* by the ſucceſſive application of ſeveral diviſions of the circle to the index.

Or thus:—Provide two wooden frames, A B, and C D (*Fig.* 11.) with grooves therein; and between thoſe grooves fit two thin leaves of aſh, A E F C, and G B D H, ſo as they may eaſily ſlide either way: at the extremes of the frame A, B, C, D, confine the leaves with nails, leaving between them the ſpace E G H F, about an inch wide. On I faſten a ſlip of braſs dented, I K; and in L a little dented wheel, upon whoſe axis, on the other ſide of the machine, an index is to be put. Laſtly, from the center of the axis, on the ſame ſide, draw a circle, and divide it into any number of equal parts.

Now, it being found by experience, that aſh-wood readily imbibes the moiſture of the *air*, and ſwells therewith; and as that moiſture ſlackens ſhrinks again; upon any increaſe of the moiſture of the *air*, the two leaves A F and B H growing turgid, will approach nearer each other: and again, as the moiſture abates, they will ſhrink, and again recede. Hence as the diſtance of the leaves can neither be increaſed nor diminiſhed, without turning the wheel L, the Index will point out the changes in reſpect of humidity and ſiccity.

Or thus:—As all the hygrometers above deſcribed become ſenſibly leſs and leſs accurate; and at length undergo no ſenſible alteration at all from the humidity of the *air*, the following one is much more laſting.

Take a *moneſcope*, and inſtead of the exhauſted ball E (*Fig.* 12.) ſubſtitute a ſponge, or other body, which eaſily imbibes moiſture. To prepare the ſponge it may be neceſſary, firſt, to waſh it

in water; and when dry again, in water and vinegar, wherein ſal armoniack, or ſalt of tartar has been diſſolved, and let it dry again.

Now, if the air become moiſt, the ſponge growing heavier will ponderate; if dry, the ſponge will be hoiſted up; and conſequently the index will ſhew the increaſe or decreaſe of the humidity of the *air*.

In the laſt mentioned *hygrometer*, Mr. *Gould*, in the *Philoſophical tranſactions*, inſtead of a ſponge recommends oil of vitriol, which is found to grow ſenſibly lighter or heavier, in proportion to the greater or leſſer quantity of moiſture it imbibes from the *air*; ſo that being ſatiated in the moiſteſt weather, it afterwards retains or loſes its acquired weight, as the *air* proves more or leſs moiſt. The alteration is ſo great that in the ſpace of fifty-ſeven days, it has been known to change its weight from three drachms to nine; and has ſhifted an index or tongue of a ballance, 30 degrees. A ſingle grain, after its full increaſe, has varied its æquilibrium ſo ſenſibly, that the tongue of a ballance only an inch and a half long, deſcribed an inch, one third of an inch in compaſs; which arch would have been almoſt three inches, if the tongue had been one foot, even with ſo ſmall a quantity of liquor; conſequently, if more liquor expanded over a large ſurface were uſed, a pair of ſcales might afford as nice a *hygrometer* as any yet invented. The ſame author ſuggeſts, that ſpirit of ſulphur per campanam, or oil of tartar per deliquium, or the liquor of fixed nitre, might be ſubſtituted in lieu of oil of vitriol.

This ballance may be contrived two ways, by either having the pin in the middle of the beam, with a ſlender tongue, a foot and a half long, pointing to the diviſions on an arched plate, as repreſented in *Fig.* 12.

Or, the ſcale with the liquor may be hung to the point of the beam near the pin, and the other extreme be made ſo long, as to deſcribe a large arch on a board placed for the purpoſe, as repreſented *Fig.* 13.

Wind being only air in motion, is alſo as ſuch of this province *pneumaticks*; and the force thereof is determined experimentally, by a peculiar machine, called *anemometer*.

The Anemometer is variouſly contrived: in the *Philoſophical Tranſactions* we have one deſcribed, wherein the wind being ſuppoſed to blow directly againſt a flat ſide, or board that moves along the graduated limb of a quadrant; the number of degrees it advances, ſhews the comparative force of the wind.

Wolfius gives the ſtructure of another, which is moved by means of ſails A B C D (*Fig.* 17.) like thoſe of a wind mill; which raiſe a weight L, that, ſtill the higher it goes receding further from the center of motion, by ſliding along an hollow arm K M, fitted to the axis of the ſails, becomes heavier and heavier, and preſſes more and more on the arm, till being a counterpoiſe to the force of the wind on the ſails, it ſtops the motion thereof. An index, then, M N, fitted upon the ſame axis at right angles with the arm, by its riſing or falling, points out the ſtrength of wind, on a plane divided like a dial-plate into degrees.

M. *d'Onſenbray*, has invented a new *anemometer*, which of itſelf expreſſes on paper, not only the ſeveral winds that have blown during the ſpace of 24 hours, and what hour each began, and ended, but alſo the different ſtrengths or velocities of each.

Wind-mills being machines, which receive their motion from the impulſe of the wind, come alſo under this article.

The *wind-mill*, though a machine common enough, has yet ſomewhat in it more ingenious than it is uſually imagined.——Add, that it is commonly allowed to have a degree of perfection, which few of the popular engines have attained to, and which the makers are but little aware of. Though the new geometry has furniſhed ample matter for its improvement.

The internal ſtructure of the *wind-mill* is much the ſame with that of water-mills. The difference between them lies chiefly in an external apparatus, for the application of the power.

This apparatus conſiſts of an axis E F (*Fig.* 15.) through which paſs two arms, or yards, A B and C D, interſecting each other at right angles in E, whoſe length is uſually about 32 feet: on theſe yards are formed a kind of ſails, vanes, or flights, in the figure of the trapezeums, with parallel baſes, the greater whereof H I, is about ſix feet, and the leſs F G, determined by radii drawn from the center E, to I and H.

Theſe ſails are to be capable of being always turned to the wind, that they may receive its impreſſions: in order to which there are two different contrivances, which conſtitute the two different kinds of *wind-mills* in uſe.

In the one, the whole machine is ſuſtained upon a moveable arbor or axis, perpendicular to the horizon, on a ſtand or foot; and turn'd occaſionally this way or that by means of a lever.

In the other, only the cover or roof of the machine, with the axis and ſails, turn round. In order to which the cover is built turret-wiſe, and the turret encompaſſed with a wooden ring, wherein is a groove, at the bottom whereof are placed, at certain diſtances, a number of braſs truckles, and within the groove is another ring, upon which the whole turret ſtands. To the moveable ring are connected beams *a b* and *f c*; and to the beam *a b* in *b* is faſtened a rope, which, at the other extream

tream thereof is fitted to a windlaſs, or axis in peritochio: this rope being drawn through the iron hook G, and the windlaſs turned, the ſails will be moved round, and put in the direction requir'd.

M. *Parent* conſidering (whence an *elliptical wind-mill*) what figure the ſails of a *wind mill* ſhall have, to receive the greateſt impulſe from the wind, he determines it to be a ſector of an ellipſis, whoſe center is that of the axis or arbor of the mill; and the little ſemi-axis, the height of thirty-two feet; as for the greater, it follows neceſſarily from the rules that direct the ſail to be inclined to the axis in an angle of 55 degrees.

On this foot he aſſumes four ſuch ſails, each whereof is one fourth of an ellipſis; which he ſhews, will receive all the wind, and loſe none, as the common ones do. Theſe four ſurfaces multiplied by the lever, with which the wind acts on one of them, expreſs the whole power the wind had to move the machine, or the whole power the machine has when in motion.

The ſame manner of reaſoning, applied to a common *wind-mill*, whoſe ſails are rectangular, and their length about five times their breadth; ſhews that the *elliptick wind-mill* has above ſeven times the power of the common one. A prodigious advantage! and worthy ſure, to have the common practice ſet aſide for, could ſo common a practice be eaſily changed.

A *wind-mill*, with ſix elliptick ſails, he ſhews, would ſtill have more power than one with four.---It would only have the ſame ſurface with the four; ſince the four contain the whole ſpace of the ellipſis as well as the ſix. But the force of the ſix would be greater than that of the four, in the ratio of 245 to 231. If it were deſired to have only two ſails, each being a ſemi-ellipſis, the ſurface would be ſtill the ſame, but the power would be diminiſhed, by near one third of that with ſix ſails; by reaſon the greatneſs of the ſectors would much ſhorten the levers with which the wind acts.

But as the elliptical ſails would be ſomething ſo new, that there is little room to expect they will come into common uſe; the ſame author has conſider'd which form, among the rectangular ones, will be the moſt advantageous, *i. e.* which, the product of whoſe ſurface, by the lever of the wind, will be the greateſt. And by the method *de maximis & minimis* (explained in my treatiſe of *mechanicks*, under the letter *M*) he finds it very different from the common ones.

The reſult of his enquiry is, that the width of the rectangular ſail, ſhould be nearly double its length; whereas the length is uſually made almoſt fives times the width. Add, that as we call height or length, the dimenſion which is taken from the center of the axis; the greateſt dimenſion of the new rectangular ſail will be turned towards the axis, and the ſmalleſt from it; quite contrary to the poſition of the common ſails.

The power of a *wind-mill*, with four of theſe new rectangular ſails, M. *Parent* ſhews will be to the power of four elliptick ſails, nearly as 13 to 23; which leaves a conſiderable advantage on the ſide of the elliptick ones: yet will the force of the new rectangular ſails be conſiderably greater than that of the common ones.

M. *Parent*, likewiſe, conſiders what number of the new ſails will be the moſt advantageous, and finds that the fewer ſails the more ſurface there will be, but the leſs power. The ratio of the power of a *wind mill* with ſix ſails, will be to another with four, nearly as 14 to 13: and the power of another with two, will be to that with four, nearly as 13 to 9.

As to the common *wind-mill*, its power ſtill diminiſhes as the breadth of the ſails is ſmaller, in proportion to the length. The uſual proportion, therefore, of 5 to 1, is exceedingly advantageous.

The uſes of this new theory of *wind-mills* are very obvious—The more power a *wind-mill* has, the ſwifter it turns, the more it diſpatches, and the leſs wind it needs. Add, that on this theory one may have a *wind-mill*, whoſe ſails ſhall be a deal ſhorter, and yet the power greater than the common one.

POETRY.

POETRY, or *poeſy*, is an art founded on a natural genius of compoſing poems, or other pieces in *verſe*.

VERSE, (*verſus*) is a line or part of a diſcourſe, conſiſting of a certain number of long or ſhort ſyllables, which run with an agreeable cadence.

The *Greek* and *Latin* verſes (which are the only ones learned in the ſchools) conſiſt of a certain number of feet, diſpoſed in a certain order.

Verſes are of various kinds; ſome denominated from the number of feet whereof they are compoſed; as the *monometer*, *dimeter*, *trimeter*, *tetrameter*, *pentameter*, *exameter*, &c. ſome from the kinds of feet uſed in them; as the *pyrrhichian*, *proceleuſmatick*, *iambick*, *trochaick*, *dactylick*, *anapaſtick*,

ſtick, *ſpondaick*, *chor-iambick*, *rindi-dactylick*, and *dactylotrochaick*.——Sometimes from the names of the inventor, or the authors who have uſed them with more ſucceſs; as the *anacreontick*, *archilochian*, *hipponactick*, *pheredratian*, *glyconian*, *alcmanian*, *aſclepiadean*, *alcaick*, *ſteſichorian*, *phaliſcan*, *ariſtophanian*, *callimachian*, *galliambick*, *phalæcian*, and *ſapphick*. Sometimes from the ſubject, or the circumſtances of the compoſition; as the *heroick*, *elegiack*, *adonick*, &c.

The *verſes* moſt commonly uſed in the *Latin* poetry, are the *hexameter*, *pentameter*, *iambick*, and *ſapphick*; and almoſt the only ones learned in the ſchools.

The HEXAMETER is a verſe conſiſting of ſix feet, the firſt four thereof may be indifferently *dactyls*, or *ſpondees*; but the fifth muſt be always a *dactyl*, and the laſt a *ſpondee*.

This ſort of *verſe* is uſed both in the *Greek* and *Latin* poetry; ſuch is that of *Homer*, for the *Greek*.

Εις νδωμ εεχηλας, εχει Θεος εκδικον ημαρ.

And that of *Virgil*, for the *Latin*:

Diſcite juſtitiam moniti, & non temnere divos.

Epick poems, as the *Iliad*, *Odyſſee*, *Æneid*, and all the other works of *Virgil*, conſiſt of *hexameter* verſes alone: elegies and epiſtles ordinarily conſiſt alternately of *hexameters* and *pentameters*.

A *foot*, in the *Greek* and *Latin* poetry, is a meaſure compoſed of a certain number of long and ſhort ſyllables; and conſequently depends entirely on quantity and meaſure; which quantity denotes the meaſure or magnitude of the ſyllables, or that which determines them to be called *long* or *ſhort*.

The *quantities* are uſed to be diſtinguiſhed by the characters ˘ ſhort, and - long.

Some authors confound the *quantities* with the accent; but the difference is glaring; the former being the length or ſhortneſs of a ſyllable, the latter the raiſing or falling of the voice.

There are different kinds of feet, — viz. the *ſpondee*, *iambic*, *trochee*, and *pyrrich*, which conſiſt of two ſyllables each.—The *dactyl*, *anapæſt*, *moloſſus*, *tribrach*, *bacchius*, *anti-bacchius*, *amphibrachys*, and *creticus*, conſiſting of three ſyllables each.—The *proceleuſmaticus*, *choriambus*, and *epitrite*, which are of four ſyllables each.

The SPONDEE, in the *Greek* and *Latin* proſody, is a foot of verſe, conſiſting of two long ſyllables.—As *vertunt*.

The IAMBIC is a foot conſiſting of a ſhort ſyllable, followed by a long one; as in *Dĕī*, *mĕās*.

The PYRRICHIUS, or PYRRICH is a foot conſiſting of two ſyllables, both ſhort; — as *dĕcĕs*.— Among the antients this foot is called *periambus*; by others *hegemona*.

The DACTYL is a foot conſiſting of a long ſyllable, followed by two ſhort ones: — as *cārmĭnĕ*, &c.

The *ſpondee* has an even, ſtrong, and ſteady pace like a trot: the *dactyl* reſembles the nimbler ſtrokes of a gallop.

ANAPÆST is a foot, conſiſting of two ſhort, and one long ſyllable; — as *lĕgĕrēnt*.

The MOLOSSUS is a foot, conſiſting of three long ſyllables; — as *aūdīrī*.

The TRIBRACH is a foot, conſiſting of three ſyllables, and thoſe all ſhort: — as *mĕlĭŭs*. Some of the antients call this foot *trochæus*.

The BACCHIUS is a foot, conſiſting of three ſyllables; whereof the firſt is ſhort, and the others long. — as *ĕgēſtas*.

The ANTIBACCHIUS is a foot, conſiſting of three ſyllables; the two firſt whereof are long, and the third ſhort: — as *cāntūrĕ*.

The AMPHIBRACHYS is a foot, conſiſting of three ſyllables, the firſt and laſt whereof are ſhort, and that in the middle long: — as *ămārĕ*.

The CHORIAMBUS is a foot compounded of a choræus, or trochæus, and an iambus.—It conſiſts of four ſyllables; of which the firſt and laſt are long; and the two middle ones ſhort: — as *Filiŏlus*.

The EPITRITE is a foot conſiſting of four ſyllables, three long, and one ſhort.

Grammarians reckon four ſpecies of *epitrites*; the firſt conſiſting of an iambus and ſpondee: — as *ſălūtāntēs*.—The ſecond of a trochee and ſpondee: as *cōncĭtāti*.—The third of a ſpondee and an iambus: as *cōmmūnĭcāns*.—And the fourth of a ſpondee and trochee: as *īncantārĕ*.

The PROCELEUSMATICUS is a foot conſiſting of four ſhort ſyllables: as *ărĭĕtăt*.

The PENTAMETER verſe, conſiſt of five feet, or metres.—The two firſt feet may be either *dactyls* or *ſpondees*; the third always a *ſpondee*; and the two laſt *anapæſt*: thus;

Carmini|bus vi|ves tem|pus in o|mne meis.

In all kinds of verſe, the poet ſhould take great care to mark well the *cæſures*, which is a certain agreeable diviſion of the words between the feet of the verſe, whereby the laſt ſyllable of a word becomes the firſt of a foot.

As in —

Arma virumque cano trojæ qui primus ab oris.

Where the ſyllables *no* and *jæ* are cæſures.

IAMBICK *verſes* are a kind of verſe, conſiſting in great part of *iambick* feet.

Iambick verſes may be conſider'd, either with regard to the diverſity. or the number of their feet; under each of which head, there are diſtinct kinds

which have different names. — 1. Pure *iambicks*, or those which consist entirely of *iambus*'s; as the fourth piece of *Catule*, made in praise of a ship.

Phaselus ille, quem videtis hospites.

The second kind are those called simply *iambicks*.—These have no *iambus*'s, but in the even feet; though there are sometimes *trybachys*'s added to them, excepting to the last, which is always an *iambus*; and in the uneven feet they have *spondees*, *anapæsts*, and even a *dactyl* in the first; such is that of *Medea* in *Ovid*:

Servare potui, perdere an possim rogas?

The third kind are the free *iambick* verses, in which it is not absolutely necessary there should be any *iambus*, excepting in the last foot; of which kind are all those of *Phædrus*:

Amittit merito proprium, qui alienum appetit.

In comedies, the authors seldom confine themselves more, frequently less, as we may observe in *Plautus* and *Terence*; but the sixth is always indispensibly an *iambus*.

As to the varieties occasioned by the number of syllables; — *Dimeter iambick*, is that which has but four feet:

Queruntur in sylvis aves.

Those which have six are called *trimeters*: these are the most beautiful, and are used principally for the theatre; particularly in tragedy; wherein they are vastly preferable to the verses, often ten or twelve feet, used in the modern drama; in regard they come nearer to the nature of prose, and favour less of art and affectation.

Dii conjugales, tuque genialis tori
Lucina custos, &c.

Those with eight are called *tetrameters*, and are only used in comedies:

Pecuniam in loco negligere, maximum est lucrum.
Terent.

Some add an *iambick monometer*, with two feet,

Virtus beat.

They are called *monometers*, *dimeters*, *trimeters*, and *tetrameters*; that is, of one, two, three, and four measures, because a measure consisted of two feet; the *Greeks* measuring their verses, two feet by two feet, or by dipodys, or epitrites, joining the *iambus* and *spondee* together.

All the *iambicks* hitherto mentioned are *perfect*; they have their just number of feet, without any thing either deficient or redundant.—The *imperfect iambicks* are of three kinds; the *catalectick*, which wants a syllable:

Musæ Jovem canebant.

The *brachycatalectick*, which wants an entire foot:

Musæ Jovis gnatæ.

The *hypercatalectick*, which have either a foot or a syllable too much:

Musæ sorores sunt Minervæ,
Musæ sorores Palladis lugent.

Many of the hymns and anthems used in the church are *dimeter iambicks*, that is, consisting of four feet.

The SAPPHICK, is a kind of verse much used by the *Greeks* and *Latins*, and consists of eleven syllables, or five feet; whereof the first, fourth, and fifth, are troches, the second a spondee, and the third a dactyl, as in,

Integer vitæ, scelerisque; purus,
Non eget mauri jaculis nec arcu. Hor.

Three verses of this kind closed with an *adonick* verse, consisting of a dactyl and spondee, usually make a strophe.

The ADONICK consists of a dactyl, and a spondee, or a trochee.—As *rara juventus*.

The chief use of the *adonick* is at the end of each strophe of sapphick verse; or among aristophanick anapæsts in the antient tragedy.

But to make a verse, there are further required certain agreeable cadences; and a certain harmony in the order, quantities, *&c.* of the feet and syllables; which make the piece musical to the ear, and fit for singing: and this is called *numbers* in poetry.

The *numbers* constitute the air and character of a verse; and denominate it either *smooth*, *soft*, *low*, *rough*, or *sonorous*.

But what is chiefly required in making *verses*, is an elevated, bold, figurative manner of diction: this manner is a thing so peculiar to this kind of writing, that without it, the most exact arrangement of longs and shorts, does not constitute verse so much as a sort of measured prose.

When we have made a *verse*, the next thing we must do, to know if it be a good one, is to scan it, *i. e.* measure it, to see what number of feet and syllables it contains, and whether or no the quantities, that is, the long and short syllables, be duly observed.

A POEM is a composition in verse, of a due length and measure.

There are *poems* of various kinds, some denominated from the persons who first invented, or most used them, as the *archilochia*, *sapphick*, &c.—Others from their composition, as the *monocolon*, consisting of one kind of verse; *dicolon*, of two; and *tricolon*, of three kinds.——Others from their entireness or deficiency; as *brachycatalectus*, which wants two syllables; *catalectus*, which wants one; *acatalectus*, none; and *hypercatalectus*, which has a syllable too much, which if cut off at the beginning of the next verse, the verse is said to be *hypermeter*.——Others are denominated from the subject

subject matter; as the *apobaterion*, *epibaterion*, *epinicion*, *epithalamium*, *genethliack*, *propemptick*, *elegiack*, *satyrick*, *epicedion*, *epitaph*, *threnos* or *lamentation*, *encomiastick*, *panegyrick*, *soterick*, *lyrick*, *pastoral*, &c.——Others from the manner of narration; as *exegetick*, which relates a thing under the author's own person, *dramatick* and *epick*.

The Apobaterion, among the antients, was a farewell speech, or poem, made by a person on his departure out of his own country, or some other place where he had been kindly received and entertained.

Such is that of *Æneas* to *Helenus*, and *Andromache*, *Æn. lib.* III.

The Epilaterion is a poetical composition in use among the antient *Greeks*. When any person of condition and quality returned home after a long absence or journey, into another country, he called together his friends and fellow-citizens, and made them a speech, or rehearsed them a copy of verses, wherein he returned solemn thanks to the immortal gods for his happy return, and ended with an address, by way of compliment, to his fellow-citizens.

These verses made what the *Greeks* call ἐπιβατήριον, *epilaterium*, of ἐπιβαίνω, *I go abroad*.

The Epinicion was a poem or composition, on occasion of a victory obtained. *Scaliger* treats expressly of the *epinicion*, in his poeticks. *lib* 1. *c.* 44.

The Epithalamium is a nuptial song, or a composition, usually in verse, on occasion of a marriage between two persons of eminence.

The topicks it chiefly consists on, are the praises of matrimony, and of the married couple; with the pomp and order of the marriage solemnity: It concludes with prayers to the gods for their prosperity, their happy offspring, *&c*——*Catullus* exceeded all antiquity in his *epithalamiums*; and the chevalier *Marino* all the moderns.

But all these and all those which follow are not properly to be called poems, and do not all belong to the grand poetry; since of all pieces of *poetry*, the epick and dramatick deserve that name by way of eminence.

The Epick is an heroick poem, or a poem reciting some great and signal transaction of a hero; called also *epopœia*.

Such are the *Iliad* and *Odyssee* of *Homer*, the *Æneid* of *Virgil*, the *Gierusolemme* of *Tasso*, and the *Paradise lost* of *Milton*; which are the principal poems of the *epick* kind.

The criticks lay down four qualifications, as necessary to the *epick* and tragick action. The first *unity*; the second *length*; the third *importance*; and the fourth *duration*; to which some add a fifth, *integrity*.

The *unity* of the *epick* action, M. *Dacier* observes, does not consist in the *unity* of the hero, or in the *unity* of his character and manner. Though these be circumstances necessary thereto. The *unity of action* requires that there be but one principal action, of which all the rest are to be incidents or dependencies.

F. *Bossu* assigns three things requisite thereto. The first, that no episode be used, but what is fetched from the plan and ground of the action, and which is a natural member of that body: the second, that these episodes and members be well connected with each other: the third is not to finish any episode, so as it may appear a whole action; but to let each be always seen in its quality of member of the body and an unfinished part.

As for the *unity* of time it is not very well established.

But the length of the poem *Aristotle* gives us a rule for, which is, that it be such, as it may be read over in one day.

As to the importance of the *epick* action, there are two ways of providing for it: the first by the dignity and importance of the persons. This way alone *Homer* makes use of; there being otherwise nothing great and important in his models, but what might have happen'd to ordinary persons. The second by the importance of the *action* itself, such as the establishment or downfal of a religion, or a state, which is *Virgil*'s action, and in which he has much the advantage of *Homer*.

Bossu mentions a third way of making the action important, *viz.* by giving a higher idea of the personages, than what the reader conceives of all that is great among men.—This is done by comparing the men of the poem with the men of the present time.

The action of the *epick poetry* is like that of the drama, susceptible of *oratorial narration*, which constitutes its species; the qualities thereof are, that it be agreeable, probable, moving, surprizing, and active.

Boileau gives the following rules for the *epick poem*,

1. He advises the poet to chuse a hero, deserving the attention of the reader, and capable to flatter his curiosity, and engage him to proceed further, without being tired of reading; such a hero, as his great valour, rare virtues, and even his imperfections, may deserve to be admired; and high feats worthy of being heard; such as *Alexander*, *Cæsar*, &c. And not such as *Polynice* and his perfidious brother, for one is soon tired with the deeds of a common conqueror.

2. He

2. He forewarns him againſt loading his ſubject with too many incidents; ſince often, ſays he, a too great abundance, impoveriſh the matter.

3. He ought to be lively and quick in his narrations; rich and pompous in his deſcriptions; without ever introducing into them low or mean circumſtances.

4. The beginning of his poem ſhould be ſimple, and without affectation; without promiſing more at firſt than he can perform in the ſequel.

5. His work muſt be diverſified with a great number of figures; mixing, as we have already obſerved, the agreeable with the uſeful; ſince a too tedious, and heavy ſublime, is always hateful.

The DRAMA is a piece or poem, compoſed for the ſtage.

Our *drama*'s are *tragedies* and *comedies*.

The *primary parts* of the *drama*, as divided by the antients, are the *protaſis*, *epitaſis*, *cataſtaſis*, and *cataſtrophe*.

The *ſecondary parts* are the *acts* and *ſcenes*.

The *acceſſary parts* are the *argument* or *ſummary*, the *prologue*, *chorus*, *mimus*, *ſatura*, and *atellana*.

Laſtly, the *epilogue*, which pointed out the uſe of the piece, or conveyed ſome other notice to the audience, in the poet's name.

Now let's explain every one of thoſe parts in particular, beginning by the *primary parts*.

The PROTASIS, in the antient drama, was the firſt part of a comick and tragick piece; wherein the ſeveral perſons of the play are ſhewn; their characters and manners intimated, and the action, which is to make the ſubject of the piece, propoſed, and entered upon.

The antient *protaſis* might go about as far as our two firſt acts.——Where the *protaſis* ended, the *epitaſis* commenced.

The EPITASIS, was the ſecond part or diviſion of a dramatick poem; wherein the plot or action propos'd, and enter'd upon in the firſt part or *protaſis*, was carried on, heighten'd, warmed, and worked upon, till it arrived at its ſtate or height, called the *cataſtaſis*.

The CATASTASIS, was the third part of the antient drama; being that wherein the intrigue or action ſet on foot on the *epitaſis*, is ſupported, carried on, and heighten'd, till it be ripe for the unravelling in the *cataſtrophe*.

The CATASTROPHE made the fourth and laſt part in the antient drama; or that immediately ſucceeding the *cataſtaſis*.

The *cataſtrophe* is the change or revolution of a dramatick poem; or the turn which unravels the intrigue, and terminates the piece.

The *cataſtrophe* is either *ſimple* or *implex*, whence alſo the fable and action are denominated.

In the firſt there is no change in the ſtate of the principal perſons, nor any diſcovery or unravelling; the plot being only a mere paſſage out of agitation to quiet and repoſe. This *cataſtrophe* is rather accommodated to the nature of epopœia, than of tragedy. Indeed we meet with it in ſome of the antients, but it is out of doors among the moderns. In the ſecond, the principal perſon undergoes a change of fortune, ſometimes by means of a diſcovery, and ſometimes without.

The qualifications of this change, or peripetia are, that it be probable and neceſſary, in order to be probable, it is required it be the natural reſult or effect of the foregoing actions, *i. e.* it muſt ſpring from the ſubject itſelf, or take its riſe from the incidents; and not be introduced merely to ſerve a turn. The diſcovery in the *cataſtrophe* muſt have the ſame qualifications as the *cataſtrophe* itſelf, whereas it is a principal part: it muſt be both probable and neceſſary. To be probable, it muſt ſpring out of the ſubject itſelf; not be effected by means of marks, or tokens, rings, bracelets, or by a mere recollection, as is frequently done both by the antients and moderns. To be neceſſary, it muſt leave the perſons it concerns, in the ſame ſentiments they had before, but ſtill produce either love or hatred, *&c.* Sometimes the change conſiſts in the diſcovery; ſometimes it follows at a diſtance, and ſometimes reſults immediately from it, which is the moſt beautiful kind: and thus it is in *œdipus*.

Dryden thinks a *cataſtrophe*, reſulting from a mere change in the ſentiments, and reſolutions of a perſon, without any farther machinery, may be ſo managed as to become exceedingly beautiful, nay preferable to any other. It is a diſpute among the criticks, whether the *cataſtrophe* ſhould always fall out happily and favourably on the ſide of virtue, or not? *i. e.* whether virtue is always to be rewarded, and vice puniſhed in the *cataſtrophe*? but the reaſons on the negative ſide ſeem the ſtrongeſt, *Ariſtotle* prefers a ſhocking *cataſtrophe* to a happy one; in regard the moving of terror and pity, which is the aim of tragedy, is better effected by the former than the latter.

Boſſu divides the *cataſtrophe*, at leaſt, with regard to the epopœa, into the unravelling or *denouement*; and the *achevement*, or finiſhing; the laſt of which he makes the reſult of the firſt; and to conſiſt in the hero's paſſage out of a ſtate of trouble and agitation, to reſt and quiet. This period is but a point, without extent or duration; in which it differs from the firſt, which comprehends every thing after the knot or plot laid. He adds,

that there are ſeveral unravellings in the piece; in regard there are ſeveral knots which beget one another: the finiſhing is the end of the laſt unravelling.

As to the ſecondary parts, *viz. acts* and *ſcenes*.

The Acts are certain diviſions or principal parts in a dramatick poem, contrived to give a reſpite or breathing time both to the actors and ſpectators.

In the interval between the acts, the theatre remains empty, and without any action viſible to the ſpectators; though it is ſuppoſed all the while there is one paſſing out of ſight.

It was the *Romans* who firſt introduced acts into the drama; and in *Horace's* time the five acts were grown into a law; and all plays are held irregular, that have either more or leſs than five acts.

The *firſt* is to propoſe the matter or argument of the fable, and to ſhew the principal character. —The ſecond, to bring the affair or buſineſs opon the carpet. — The third, to furniſh obſtacles and difficulties. — The fourth, either points a remedy for thoſe difficulties, or finds new in the attempt.—The fifth puts an end to all by a diſcovery.

Some are of opinion, that, on the principles of that great maſter of the drama, *Ariſtotle*, we may have a juſt and regular play, though only divided into *three acts*.

The *acts* are ſubdivided into *ſcenes*.

A Scene is a part or diviſion of a dramatick poem, determin'd by a new actor's entering.

Whenever a new actor appears, or an old one diſappears, the action is changed into other hands, and a new *ſcene* then commences.

It is one of the laws of the ſtage, that the *ſcenes* be well connected: that is, that one ſucceed another in ſuch manner, as that the ſtage is never quite empty till the end of the act.

As to the *acceſſary* parts.—The Argument or *ſummary*, was an abridgment of the whole play; which at preſent, is almoſt out of uſe.

The Prologue is a diſcourſe addreſſed to the audience, before the drama or play begins.

The original intention of the *prologue*, was to advertiſe the audience of the ſubject of the piece, and to prepare them to enter more eaſily into the action; and ſometimes to make an apology for the poet.

The Chorus, was one, or more perſons, preſent on the ſtage during the repreſentation, and ſuppoſed to be by-ſtanders thereto, without any particular ſhare or intereſt in the action.

The *chorus* in *comedy* was at firſt no more than a ſingle perſon, who ſpoke in the antient compoſures for the ſtage; the poets by degrees added to him another; then two, afterwards three, and at laſt more; ſo that the moſt antient comedies had nothing but the chorus.

Laſtly, the Epilogue is a ſpeech addreſſed to the audience when the play is over, by one of the principal perſons or actors therein; containing uſually ſome reflections on certain incidents in the play, particularly thoſe of the parts of the perſon who ſpeaks it.

In the modern tragedy, the *epilogue* has uſually ſomewhat of pleaſantry; intended, we ſuppoſe, to compoſe the paſſions raiſed in the courſe of the repreſentation, and ſend away the audience in good humour.

We'll examine next the whole compoſition, beginning with *tragedy*.

The Tragedy is a dramatick poem, repreſenting ſome ſignal action performed by illuſtrious perſons, and which has frequently a fatal iſſue or end.

Tragedy, in its original, M. *Hedelin* obſerves, was only a hymn ſung in honour of *Bacchus* by ſeverral perſons, who, together, made a chorus of muſick with dances and inſtruments.

As this was long and might fatigue the ſingers, as well as tire the audience, they bethought themſelves to divide the ſinging of the chorus into ſeveral parts, and to have certain recitations in the intervals, as already obſerved.

Accordingly *Theſpis* firſt introduced a perſon on the ſtage with this view: *Æſchyllus* finding one perſon inſufficient, introduced a ſecond to entertain the audience more agreeably by a dialogue: he alſo cloathed his perſons more decently, and firſt put on them the buſkin.

The perſons who made theſe recitations on the ſcene, were called actors; ſo that *tragedy* at firſt was without actors. And what they thus rehearſed, being things added to the ſinging of the chorus, whereof they were no neceſſary part, were called *epiſodes*.

Sophocles found that two perſons were not enough for the variety of incidents, and therefore introduced a third. And here the *Greeks* ſeem to have ſtopped; at leaſt it is very rare that they introduce four ſpeakers in the ſame ſcene.

When *tragedy* was got into a better form, they changed the meaſure of its verſe, and endeavoured to bring the action within the compaſs of a day.

The ſeveral parts of the modern *tragedy*, are the *act*, *ſcene*, *fable*, *characters*, *manners*. We have already

already explained the *act* and the *ſcene*, therefore we'll now take notice of the *fable*, &c.

The ACTION, in the tragedy, requires *unity*, *integrity*, *importance*, and *duration*.

In the drama, there are three unities to be obſerv'd; the *unity* of *action*, that of *time*, and that of the *place*.

The *unity* of the dramatick action, conſiſts in *tragedies*, in the unity of the danger; and, in *comedies*, in that of the intrigue; and this not only in the plan of the *fable*, but alſo in the fable *extended*, and filled with *epiſodes*.

The *epiſodes* are to be worked in without corrupting the *unity*, or forming a double action; and the ſeveral members are to be ſo connected together, as to be conſiſtent with that continuity of action, ſo neceſſary to the body, and which *Horace* preſcribes, when he ſays, *Sit quodvis ſimplex duntaxat & unum.*

To the *unity of time*, it is required in the drama, that the action be included in the ſpace of a day.

The antient tragick poets ſometimes diſpenſed with this rule, and among the modern *Engliſh* ones many of them diſallow it: few of them practiſe it.

As to the *unity of place*, and *ſcene*, neither *Horace* nor *Ariſtotle* gives us any rules relating thereto. It has been agreed, that what paſſes any where in the ſame town, or city, ſhall be allowed for *unity of place*.—At leaſt, if two different places be unavoidable; yet the place is never to be changed in the ſame act.

In order to the *integrity of the action*, it is neceſſary, according to *Ariſtotle*, that it have a beginning, middle, and end. The *cauſes* and *deſigns* of a man's doing an *action*, are the *beginning*; the *effects* of theſe cauſes, and the *difficulties* met withal in the execution of thoſe deſigns, are the *middle* of it; and the *unravelling* and extricating of thoſe difficulties, the *end* of the *action*.

In the *cauſes* of an *action* one may obſerve *two* oppoſite *deſigns*; the firſt and principal is that of the hero: the ſecond comprehends all their deſigns, who oppoſe the pretenſion of the hero. Theſe oppoſite cauſes do alſo produce oppoſite effects, *viz.* the endeavours of the hero to accompliſh his deſign, and the endeavours of thoſe that are againſt it. As the cauſes and deſigns are the beginning of the *action*; ſo thoſe contrary endeavours are the middle of it; and form a difficulty, plot, or intrigue, which makes the greateſt part of the poem.

The ſolution or clearing up of this difficulty, makes the *unravelling*.

The *unravelling* of the plot, or intrigue, may happen two ways, either with a diſcovery or without.

The ſeveral effects, which the unravelling produce, and the different ſtates to which it reduces the perſons, divides the *action* into ſo many kinds. If it changes the fortune of the principal perſon, it is ſaid to be with a peripetia; and the *action* is denominated *implex*, or *mixed*: if there be no peripetia, but the unravelling be a mere paſſing from *action* to repoſe, the *action* is *ſimple*.

The FABLE is uſed for the *plot* of an *epick* or *dramatick* poem; or the *action*, which makes the ſubject of ſuch poem or romance,

The *fable*, according to *Ariſtotle*, is the principal part, and, as it were, the ſoul of a poem. It muſt be conſider'd as the firſt foundation of the compoſition; or the principle which gives life and motion to all the parts. In this ſenſe the *fable* is defined, *A diſcourſe invented with art, to form the manners by inſtructions diſguiſed under the allegory of an action.*

The characters that ſpecify the epick *fable*, are theſe: it is rational and probable; it imitates a whole, and an important action, and it is long, and related in verſe.

The *fable*, according to *Ariſtotle*, conſiſts of two eſſential parts, *viz. truth*, as its foundation; and *fiction*, which diſguiſes the truth, and gives to it the form of a *fable*. The *truth* is the point of *morality* intended to be inculcated; the *fiction* is the action, or words the *inſtruction* is covered under.

To make a plot or *fable*; the firſt thing, according to the great critick juſt mentioned, is to pitch on ſome moral inſtruction to be exemplified.

The fiction may be ſo diſguiſed with the truth of hiſtory, that there ſhall not appear any fiction at all. To effect this the poet looks back into hiſtory, for the names of ſome perſons to whom the feigned action either really or probably did happen; and relates it under thoſe known names, with circumſtances which do not change any thing of the ground of the *fable*.

The CHARACTERS, in the *epopœia* and *drama*, is the reſult of the manners, or that which each perſon has ſingular and peculiar in his manners, whereby he is diſtinguiſhed from others.

There muſt be one character reign over all the reſt; and this muſt be found in every part: juſt as the ſame hero, in ſeveral paintings, ſhould have the ſame lines and features, how different ſoever his poſtures and paſſions may be.

The firſt quality, in *Homer*'s *Achilles*, is wrath: in *Ulyſſes*, diſſimulation; and in *Virgil*'s *Æneas* mildneſs: each of which may, by way of eminence be called the *character* of theſe heroes.

Theſe are never to go alone, but always to be accompanied with others, to give them the greater

luſtre, either by hiding their defects, as in *Achilles*, whoſe anger is palliated by a world of courage: or by making them center in ſome ſolid virtue, as in *Ulyſſes*, whoſe diſſimulation makes a part of his prudence; and *Æneas*, whoſe mildneſs is chiefly employed in a ſubmiſſion to the will of the gods.

Theſe ſecondary qualities of courage, prudence, and ſubmiſſion, make the goodneſs of the *character* of thoſe heroes, and even of the poems.

For the unity of *character*, we have *Horace*'s expreſs command, *ſit quodvis ſimplex, duntaxat & unum*. *Boſſu* adds, that the *character* is not leſs the ſoul of the hero and the whole action, than the fable is of the poem.

The unity of *character* is not only to be kept in the hero, and the ſeveral other perſons of the piece, but alſo in that of the poem itſelf: that is, all the *characters*, how oppoſite ſoever, muſt center and reunite in that of the hero; and be ſo ſwayed by it, as that this alone may ſeem to govern throughout the whole. Thus *Homer* makes wrath prevail throughout the whole *Iliad*; and artifice and diſſimulation throughout the *Odyſſee*: the hero's *character* is perceived every where, has its full ſwing, and is favoured by the ſimilitude of the *characters*, of ſome of the other perſons. *Virgil* has a great difficulty to grapple with to preſerve this unity; in regard of the direct oppoſition between the humours of this hero, and thoſe of ſome other of his perſons, as *Turnus*, *Mezentius*, *Dido*, &c. he therefore takes care not to carry thoſe oppoſite *characters* to their full length, but moderates and reſtrains them: and as that moderation could not flow naturally from the perſons themſelves, it is produced either by ſome paſſion, as in *Dido*; or ſome dependance, as in *Turnus* and *Mezentius*. To this artifice he adds *Epiſodes*, accommodated to the general *character*, by which he interrupts the particular actions, which require an oppoſite *character*.

The MANNERS denotes the inclinations, genius, and humour, which the poet gives to his perſons, and whereby he diſtinguiſhes his character.

Unleſs the *manners* be well expreſſed, we ſhall never be acquainted with the perſons at all; nor conſequently ſhall once be either terrified with foreſeeing their dangers, nor melted into pity by ſeeing their ſufferings.

The *manners* ſhould have four qualities; they ſhould be *good*, *like*, *ſuitable*, and *equal*.

The *manners* are good when they are well marked, or expreſſed; that is, when the diſcourſe of the perſons makes us clearly and diſtinctly ſee their inclinations, and what good or evil reſolutions they will take.

The *manners* muſt likewiſe be *ſuitable*; that is, they muſt be agreeable to the age, ſex, rank, climate, and condition of the perſon that has them.—Again, the *manners* muſt be *equal*; that is, they muſt be conſtant, or conſiſtent through the whole character; or the variety or inequality of the *manners*, as in nature, ſo in the *drama* muſt be equal. The fearful muſt never be brave, nor the brave timorous; the avaricious muſt never be liberal, nor *vice verſa*. In this part *Shakeſpear*'s *manners* are admirable.

Beſides theſe four qualities above-mentioned, there is a fifth eſſential to their beauty; which is, that they be *neceſſary*, that is, that no vicious quality, or inclination, be given to any poetick perſon, unleſs it appears to be abſolutely neceſſary, or requiſite to the carrying on of the action.

Boileau gives the following rules for the *tragedy*.

1. He will have the poet propoſe to himſelf, for the chief and principal end of his piece, the awaking gently the moſt noble of our paſſions, by moving gently the heart; or to ſpeak, in a more conciſe manner, he muſt uſe all his beſt endeavours to pleaſe and move; otherwiſe it is in vain, that he has wrote his piece according to the beſt rules of the art, and in the moſt elegant manner.

2. The firſt verſes of the piece ſhould give an idea of the ſubject, without keeping the mind of the audience in ſuſpence, by a long rigmarole of verſes, which is much more fatiguing than entertaining; ſince the ſubject is never too ſoon explained.

3. The ſcene ſhould be fixed and marked, *i. e.* a ſingle fact done in one place, and in one day, fill the theatre, from the beginning to the end of the piece.

4. Nothing incredible ſhould be offered to the ſpectator, ſince a ſurprizing abſurdity has no charms; and the mind is never moved by what it cannot believe.

5. What is not to be ſeen muſt be told, though it would be perhaps more intelligible if it was expoſed to our ſight; but there are objects which the judicious art muſt offer to the ear, and hide from the ſight.

6. The trouble increaſing always from ſcene to ſcene, being arrived to its period muſt be eaſily unfolded; for the mind is never more effectually touched, than when in a ſubject diverſified with intrigues, the truth of a ſecret, known all on a ſudden, changes all, and gives to the whole an unforeſeen face.

7. If the poet wants to repreſent heroes ſuſceptible of love, he muſt not paint them with the ſame colours he would do a ſhepherd ſubject to the ſame paſſion; for *Achilles* muſt love in another manner than *Thyrſis* does. He muſt avoid, as a great imperfection,

perfection, the ridiculous love, and other low paſſions, of the heroes of romances; though he may ſometimes allow ſome weakneſs to the moſt noble hearts. *Achilles* would diſpleaſe, was he leſs hot and paſſionate; he pleaſes when he is ſeen ſhedding tears for an affront, at thoſe ſmall imperfections, marked in his picture, the mind diſcovers eaſily nature's weakneſs. Let *Agamemnon* be proud, haughty, and intereſted, and *Æneas* religious; preſerving to each his proper character, and ſtudying the manners of the ages and countries, never giving the air and genius of a nation to another, particularly of the moderns to the antients.

COMEDY, in its proper ſenſe, is a dramatick piece repreſenting ſome agreeable and diverting tranſaction: or, an allegorical repreſentation of ſomething in private life; for the amuſement and inſtruction of the ſpectator.

Comedy, as well as *tragedy*, has its eſſential, and its integrant parts. Its eſſential parts, in the language of the antients, are the *protaſis*, *epitaſis*, *cataſtaſis*, and *cataſtrophe*, explained above.

Comedy is diſtinguiſhed from *farce*, in that the former repreſents nature as ſhe is; the other diſtorts or overcharges her. They both paint from the life, but with different views: the one to make nature known; the other to make it ridiculous.

Boileau gives the following rules for the *comedy*.

1. He will have nature to be the whole ſtudy of an author who writes *comedies*; and ſays, that whoever ſees very well man; and with a profound genius has penetrated the bottom of ſo many hidden hearts; who knows very well what a prodigal, an avaricious, an honeſt man, a coxcomb, a jealous man, *&c.* are, can bring them on the ſtage, and make them act and ſpeak before us.

2. He will have the repreſentations true, without diſguiſe, and painted with the moſt lively colours.

3. He forewarns the author againſt making his actors ſpeak at random, a young man like an old man, or *vice verſa*.

4. He adviſes him to ſtudy the court, and know the town; both being always fertile in models.

5. He ſays that the comick being an enemy of ſighs and tears; does not admit in its verſes tragical pains; neither does it allow, that an actor with obſcene expreſſions ſhould divert the mob; but only joke in a noble manner.

6. This plot well formed, muſt unravel itſelf eaſily; leaſt the action, for want of being guided by reaſon, ſhould loſe itſelf in an empty ſcene.

7. His diſcourſes every where fruitful in witty ſayings, muſt be full of paſſions curiouſly handled; and the ſcenes always well concerted together.

8. He muſt avoid all ſorts of jokes, which are contrary to good ſenſe, and never deviates from nature.

9. He concludes by ſaying, that he loves on the theatre an agreeable author, who, without diſgracing himſelf to the eyes of the ſpectators, pleaſes by reaſon alone.

A FARCE was originally a droll, pettit-ſhew, or entertainment, exhibited by charletans, and their buffoons in the open ſtreet, to gather the crowd together.

At preſent, *farce* is of a little more dignity. It is removed from the ſtreet to the theatre; and inſtead of being perform'd by jack-puddings to amuſe the rabble, is now acted by our comedians, and become the entertainment of the politeſt audiences.

The poets have reformed the wildneſs of the primitive *farces*; and brought them to the taſte and manner of comedy. The difference between the two on our ſtage, is, that the latter keeps to nature and probability; and in order to that, is confined to certain laws, unities, *&c.* preſcribed by the antient criticks.

The former diſallows of all laws, or rather ſets them aſide on occaſion. Its end is purely to pleaſe or make merry: and it ſticks at nothing which may contribute thereto, however wild and extravagant. Hence the dialogue is uſually low, the perſons of inferior rank, the fable or action trivial or ridiculous; and nature, and truth every where heighten'd and exaggerated to afford the more palpable ridicule.

There is another kind of dramatick piece, called *tragi-comedy*, repreſenting ſome action, paſſed among eminent perſons, the event whereof is not unhappy or bloody, and wherein is ſometimes admitted a mixture of leſs ſerious characters.

The *tragi-comedy* is the only caſe, wherein comedy is allowed to introduce kings and heroes.

Having thus far explained all that is underſtood by *grand poetry*, we'll proceed to *ſimple poetry*, or *verſification*, which conſiſts in *elegies*, *ſatires*, *odes*, *ſongs*, *paſtorals*, *epitaphs*, *ſonnets*, *madrigals*, &c.

AN ELEGY was originally a mournful and plaintive kind of poem.

In proceſs of time, *elegy* degenerated from its original intention, and not only matters of grief, but alſo joy, wiſhes, prayers, expoſtulations, reproaches, and almoſt every ſubject, were admitted into *elegy*.

The office of *elegy* is well delivered by M. *Boileau*.

La plaintive elegie en longs habits de deuil,
Scait, les cheveux epars, gemir ſur un cercueil:
Elle peint des amans la joye, & la triſteſſe;
Flatte, menace, irrite, appaiſe une maitreſſe.

TRANSLATED.

In mourning weeds ſad *elegy* appears,
Her hair diſhevell'd, and her eyes in tears.
Her theme; the lover's joy, but more his pains;
By turns ſhe ſings, ſooths, threatens and complains.

The diction of *elegy* ought to be clean, eaſy, perſpicuous, expreſſive of the manners, tender and pathetick; not oppreſſed with ſentences, points, &c. No apoſtrophe's are allowed; and the ſenſe to be generally cloſed in every diſtich, or two lines; at leaſt in *Latin* compoſitions.

A SATYR is a poem wherein men's follies and vices are wittily expoſed, in order to their reformation.

Satyr bears a near affinity to raillery, ridicule, lampoon, libel, &c. and ſtands oppoſed to panegyrick.

A *ſatyr* ought to be lively, pleaſant, moral, and full of variety.

Satyr may be divided with regard to the meaſure, and kind of verſe, as well as the manner of the poem, and the character, into *narrative*, *dramatick*, *mixt*, &c.

Narrative is a ſimple narration, or recital of abuſes in the poet's own perſon.—Such is the firſt of *Juvenal*.

Dramatick is that wherein ſeveral perſons diſcourſe together, whether they be nameleſs, as in the firſt of *Perſius*; or have names, as of *Caſſius* and *Damaſippus*.

Mixt is compounded of both the former; as that fine one of *Horace*, *Ibam forte via ſacra*.

Grave, and animated, which inveigh with warmth and earneſtneſs, againſt corruption and vice in every ſhape.——As thoſe of *Juvenal* and *Perſius*.

Sportive, and lighter, which ſeems to play with men's folly; but in playing, omit no opportunity of making them feel the laſh.——Such are thoſe of *Horace*.

Satyr is divided into *general*, which is levelled at common abuſes, wherein numbers are equally intereſted——And *perſonal*, which points out and expoſes particular characters.

The ODE from the *Greek* ᾠδὴ, *cantus*, a ſong, or ſinging in the antient poetry, is a ſong, or a compoſition proper to be ſung, and compoſed for that purpoſe; the ſinging uſually accompanied with ſome muſical inſtruments, chiefly the lyre.

Ode, in the modern poetry, is a lyrick poem, conſiſting of long and ſhort verſes, diſtinguiſhed into ſtanza's or ſtrophes, wherein the ſame meaſure is preſerved throughout.

It is a miſtake to imagine *Anacreon*, as the *Greeks* do, the author of lyrick poetry; ſince it appears from ſcripture to have been in uſe about a thouſand years before that poet. The characteriſtick of lyrick poetry, which diſtinguiſhes it from all others, is *ſweetneſs*. As *gravity* rules in heroick verſe; *ſimplicity* in paſtorals; *tenderneſs* and *ſoftneſs* in elegy; *ſharpneſs* and *poignancy* in *ſatyr*; *mirth* in comedy; the *pathetick* in tragedy; the *point* in epigram; ſo in the *lyrick*, the poet applies himſelf wholly to ſooth the mind of men, by the ſweetneſs and variety of the verſe, and the delicacy of the words, and thoughts; the agreeableneſs of the numbers; and the deſcription of things moſt pleaſing in their own nature.

The word *ſtrophe* is *Greek* στροφὴ, formed from στρέφω, I turn; becauſe at the end of the *ſtrophe*, the ſame meaſures return again; or rather as the term related principally to the muſick or dancing, becauſe at firſt coming in, the chorus, or the dancers turned to the left, and that meaſure ended, they turned back again to the right. What the couplet is in ſongs, and the ſtanza in epick poetry, *ſtrophe* is in *odes*.

In a *pindarick ode*, the plan of the whole is to be drawn firſt, and the places marked out where the elegant ſallies and wanderings may be beſt, and how the returns may be juſtly made to the ſubject.

The antient *odes* had originally but one ſtanza, or ſtrophe; but was at laſt divided into three parts, *ſtrophe*, *antiſtrophe*, and *epode*. The prieſts going round the altar, ſinging the praiſes of the gods, called their firſt entrance *ſtrophe*, i. e. turning to the left: the ſecond, turning to the right, they called *antiſtrophe*, q. d. returning. Laſtly, ſtanding ſtill before the altar, they ſung the remainder, which they called *epode*.

The EPODE was not confined to any preciſe number, or kind of verſes; as the *ſtrophe* and *antiſtrophe* were. But when the *ode* contained ſeveral *epodes*, *ſtrophes*, &c. they were all alike.

As the word *epode* then properly ſignifies the end of the ſong, and as in *odes*, what they called the *epode* finiſhing the ſinging: it became cuſtomary, as M. *Dacier* ſhews, for a little verſe, which being put after another, cloſed the period, and finiſhed the ſenſe which had been ſuſpended in the firſt verſe, to be called *epode*, ἐπῳδὴ.

But

But the ſignification of the word is extended ſtill further; *epode* being become a general name for all kinds of ſhort verſes, that follow one, or more long ones, of what kind ſoever they be: and in this ſenſe a pentameter is an *epode*, after an hexameter, which in reſpect thereof is a *pro ode*.

There is another ſort of *ode*, called *alcaick*, which conſiſts of four ſtrophes, each of which contains four verſes; the two firſt are *alcaick* verſes of the firſt kind, the third an iambick diameter hypercate-lutick, *i. e.* of four feet and a long ſyllable: as,

Sors exitura, & nos in æternum.

The fourth is an *alcaick* of the ſecond kind.—The entire *alcaick* ſtrophe is as follows:

Omnes eodem cogimur, omnium.
Verſatur urna, ſerius, ocius
Sors exitura, & nos in æternum
Exilium impoſitura cymbæ.

The PASTORAL is a compoſition, the ſubject whereof is ſomething in the *paſtoral*, at leaſt rural life, and the perſon ſhepherds, at leaſt ruſticks.

The *ſcene* is always in the fields or the woods.

Every *paſtoral* ſhould have a little plot or fable, which may deſerve the title of a *paſtoral ſcene*. It muſt be ſimple, and but one; yet not ſo as to refuſe all digreſſions, provided they be but ſhort. This rule of the plot is every where obſerved by *Virgil*.

The ECLOGUE is a kind of paſtoral compoſition, wherein ſhepherds are introduced converſing together.

The *eclogue*, is properly an image of the paſtoral life.

The beauty of the *eclogue*, M. *Fontenelle* obſerves, is not attached to what is rural, but rather to what is calm and eaſy in the rural life.

The word *eclogue* is formed from the *Greek* ἐκλογὴ, *choice*. So that according to the etymology of the word, *eclogue* ſhould be no more than a ſelect or choice piece; but cuſtom has determined it to a further ſignification, *viz.* a little elegant compoſition, in a ſimple, natural ſtyle and manner.

Idyllion and *eclogue*, in their primary intention, are the ſame thing: thus the *Idyllia* of *Theocritus* are pieces wrote perfectly in the ſame vein with the *eclogæ* of *Virgil*.

But cuſtom has made a difference between them, and appropriated the name *eclogue* to pieces wherein ſhepherds are introduced ſpeaking; idyllion to thoſe wrote like the *eclogue*, in a ſimple natural ſtyle, but without any ſhepherds in them.

Boileau preſcribes the following rules for the compoſition of *idyls* and *eclogues*.

1. As a ſhepherdeſs, ſays he, in the greateſt holiday, does not load her head with precious ſtones, and gold, but gathers in the neighbouring fields her fineſt ornaments; thus an elegant *idyllion*, amiable in its air, and humble in its ſtyle, muſt ſhine without pomp: its turn ſimple and natural, hate the pomp and pride of a preſumptuous verſe. Its ſweetneſs muſt flatter, tickle, and awake, but never fright the ear with great words.

2 Neither ought the *idyl* to be compoſed in a mean and low ſtyle, and the author make his ſhepherds ſpeak a clowniſh dialect; but follow a road between the two extremes, imitating in it *Theocritus* and *Virgil*.

The EPIGRAM is a ſhort poem, or compoſition in verſe, treating of one only thing, and ending with ſome point or lively ingenious thought.

It is principally the point that characteriſes the *epigram*, and diſtinguiſhes it from the madrigal.

The *epigram* is the loweſt, and leaſt conſiderable of all the productions of *poetry*; and is rather an effect of good luck, than of art to ſucceed therein. The fineſſe and ſubtility of the *epigram*, M. *Boileau* obſerves, ſhould turn on the words rather than the thought.

A MADRIGAL is a little amorous piece, containing a certain number of free unequal verſes, not tied either to the ſcrupulous regularity of the ſonnet, or the ſubtlety of an epigram, but conſiſting of ſome tender, delicate, yet ſimple thought, ſuitably expreſſed.

The *madrigal* is uſually looked on as the ſhorteſt of all the leſſer kinds of poems, and may conſiſt of fewer verſes, than either the ſonnet or rondeau. There is no other rule regarded in mingling the rhimes and verſes of different kinds, but the fancy and convenience of the author.

A SONNET is a kind of compoſition contained in fourteen verſe, *viz.* two ſtanza's or meaſures, of four verſes each, and two of three; the eight four verſes being all in two rhimes.

It is held the moſt difficult and artful of all poetical compoſitions, as requiring the laſt accuracy and exactneſs. It is to end with ſone pretty ingenious thought: the cloſe to be particularly beautiful, or the *ſonnet* is naught.

A SONG is a little compoſition, conſiſting of ſimple, eaſy, natural verſes, ſet to a tune in order to be ſung. Each ſtanza of a ſong, is called a couplet.

Its object is uſually wine, or love; whence M. *le Brun* defines a modern *ſong* to be either a ſott

and

and amorous, or a brisk and bachic thought, expressed in a few words.

Let the *song* be what it will, the verses are to be easy, natural, flowing, and to contain a certain harmony, which neither shocks the reason nor the ear; and which unite poetry and musick agreeably together.

The Fable is a tale, or feigned narration, designed either to instruct or divert; or as M. *de la Motte* defines it, an instruction disguised under the allegory of an action.

The criticks, after *Aphthonius* and *Theon*, reckon three kinds of *fables*, rational, moral, and mixed.

Rational fables, called also parables, are relations of things supposed to have been said and done by men; and which might possibly have been said or done, tho' in reality they were not. Such in the sacred writings are those of the ten virgins; of *Dives* and *Lazarus*; the prodigal son, *&c.* of these rational *fables* we have likewise about a dozen in *Phædrus*.

Moral fables, called also apologues, are those wherein beasts, trees, hammers, *&c.* are supposed to speak.

Mixed fables are those composed of both sorts, rational and moral; or wherein men and brutes are introduced conversing together. Of this we have a fine instance, in *Justin*, *lib.* xxxiii. *c.* 4. made by a petty king, to alarm the antient *Gauls* against the *Massilians*, who arriving out of *Asia* in *Spain*, charmed with the place, begged leave of the inhabitants to build a city: to this effect,

A bitch big with young, begged of a shepherd a place to lay her whelps in; which when she had obtained, she begged further leave to rear them in the same. At length the whelps being now grown up; depending on the strength of her own family, she claimed the property of the place.—So the *Massilians*, who are now only strangers, will hereafter pretend to be masters of the country.

As to the laws of *fables*; the principal are, 1st, That to every *fable* there be some interpretation annexed, to shew the moral sense, or design thereof. This interpretation, if it be placed after the *fable*, is called *affabulatio*; if before it, *præfabulatio*.—2dly, That the narration be clear, probable, short and pleasant. To preserve this probability, the manners must be expressed, and closely kept to, as in *poetry*.

An Epitaph is a monumental inscription, in honour or memory of a person defunct; or an inscription engraven, or cut on a tomb, to mark the time of a person's decease, his name, family, and usually some eloge of his virtues, or good qualities.

The style of *epitaphs* is a kind of medium between prose and verse; the jejune and the brilliant are here equally to be avoided.

Rhime is a modern invention, the product of a gothick age; *Milton* calls it the *modern bondage*.

To succeed in such kind of verses, there must be a liberty of varying the order of the words, or of changing their situation as may best suit the occasions of the poet; of making the substantive either go before, or follow after the verb, as the verse requires, *&c.*

Rhymes are either *simple* or *double*, or *triple*; tho' the two last are now disused.

Single rhymes are divided into perfect or whole *rhymes*, and imperfect or half *rhymes*.

A *whole* or *perfect rhyme* is where there is a similitude of sound, without any difference; or where a thorough identity or sound appears in the pronunciation of the two syllables, notwithstanding that there may be some difference in the orthography.

An *imperfect* or *half rhyme* is where there is a similitude with a difference, either in respect of the pronunciation, or the orthography; but chiefly the former.

There is also a jocose kind of poetry, called *burlesque*, chiefly used in the way of drollery and ridicule, to deride persons and things.

The best work we have of that taste in *French*, is the *Virgil Travesty* of *Scarron*; which was also done in *English* by *Cotton* and *Philips*; for which poor *Cotton* paid very dear, for having dressed *Dido* in the antique manner of his old aunt, and named her as an original, she resented it so much, as to carry her resentment so far as to disinherit him.

Of Romances.

As M. *Fontenelle* calls *romance* poems in prose, and *Bossu* is not averse to their being admitted as poetical pieces, I'll place them here, and say, that a *romance* is a fabulous relation of certain intrigues and adventures in the way of love or gallantry, invented to entertain and instruct the readers.

The just notion therefore of a *romance* is, that it is a discourse invented with art to please and improve the mind, and to form or mend the manners, by instructions disguised under the allegory of an action, or series of actions, related in prose, in a delightful, probable, yet surprizing manner.

A just *romance* consists of two parts, *viz.* a moral, as its foundation and end; and a fable or action, as the superstructure and means. It must also have the manners, that is, the characters must be distinguished, and the manners must be necessary, and have all the other qualities of poetical manners.

The incidents must be delightful, and to that end rightly disposed and surprizing. The sentiments fall under the same rules as the drama. But the diction is allowed to be more lofty and figurative, as being a narration; and not having terror or pity, but admiration for its end.

POTTERY.

POTTERY is the art of making earthen pots and veſſels; which art is as much ſubject to improvements as any other mechanical art.

The chief, and almoſt the only tools, or inſtruments uſed in *pottery*, are the *wheel* and the *lathe*.

The *wheel*, conſiſts of a nut, which is a beam or axis, the foot or pivot thereof plays perpendicularly on a free-ſtone ſole or bottom. From the four corners a top of this beam, which does not exceed two feet in height, ariſe four iron bars, called the *ſpokes* of the wheel, which forming diagonal lines with the beam, deſcend, and are faſtened at bottom to the edges of a ſtrong wooden circle, four feet in diameter, perfectly like the felloes of a coach wheel, except that it has neither axis nor radii; and is only joined to the beam, which ſerves it as an axis, by the iron bars. The top of the nut is flat, of a circular figure, and a foot in diameter. On this is laid a piece of the clay or earth, to be turned and faſhioned.

The *wheel* thus diſpoſed, is encompaſſed with four ſides of four different pieces of wood, ſuſtained on a wooden frame: the hind piece, which is that whereon the workman ſits, is made a little inclining towards the wheel: on the fore piece are placed the pieces of prepared earth. Laſtly, the ſide-pieces ſerve the workman to reſt his feet againſt; and are made inclining to give him more or leſs room, according to the ſize of the veſſel to be turned. By his ſide is a trough of water, wherewith from time to time he wets his hands, to prevent the earth ſticking to them.

The potter having prepared his clay or earth, and laid a piece of it ſuitable to the work he intends, on the top of the beam, ſets down; his thighs and legs much expanded, and his feet reſted on the ſide pieces, as is moſt convenient.

In this ſituation he turns the wheel round, till it has got the proper velocity; when, wetting his hands in the water, he bores the cavity of the veſſel, continuing to widen it from the middle; and thus turns it into form, turning the wheel afreſh, and wetting his hands from time to time.

When the veſſel is too thick, they uſe a flat piece of iron with a hole in the middle, and ſomewhat ſharp on one edge, to pare off what is redundant. Laſtly, when the veſſel is finiſhed, they take it off from the circular head by a wire paſſed underneath the veſſel.

The potter's *lathe*, is alſo a kind of wheel, but ſimpler, and ſlighter than the former. Its three chief members, are an iron beam or axis, three feet and a half high, and two inches in diameter; a little wooden wheel all of a piece, an inch thick, and ſeven or eight in diameter, placed horizontally a-top of the beam, and ſerving to form the veſſel on; and another larger wooden wheel, all of a piece, three inches thick, and two or three feet broad, faſtened to the ſame beam at bottom, parallel to the horizon. The beam or axis turns, by a pivot at bottom on an iron ſtand.

The workman gives the motion to the *lathe* with his feet, by puſhing the great wheel alternately with his foot; till giving it a greater or leſſer degree of motion, as his work requires.

They work with the *lathe*, with the ſame inſtruments and after the ſame manner as with the wheel; but neither the one nor the other ſerves for any more than forming the body of the veſſel, &c. The feet, handle, and ornaments, if there be any, beſides the mouldings being to be made, and ſet on by hand; if there be any ſculpture in the work, it is uſually done in earthen or wooden moulds, prepared by a ſculptor, unleſs the Potter has ſkill enough to do it himſelf, which is very rare.

The piece of earthen ware being done, it is put to dry, to a certain degree: and from thence carried to the oven to be baked. As to the glazing or varniſhing of it, it is uſually done with ſand, litharge or lead-aſhes, wood-aſhes, and ſmalt, melted into a cake.

But the moſt curious operation of this kind, is that of making *porcelain*; the proceſs thereof is as follows.

In the manufacture of *porcelain*, there are four principal things to be conſidered, *viz.* the matter it is made of, the art of forming the veſſels, and other works; the colours wherewith it is painted; and laſtly, the baking, or giving it the proper degree of fire.

There are two kinds of earths, and as many kinds of oils or varniſhes uſed in the compoſition of *porcelain*, vulgarly called *china*. The firſt earth, called *kaulin*, is beſet with glittering corpuſcles; the ſecond, called *petunſe*, is a plain white, but exceeding fine, and ſoft to the touch. They are both found in quarries twenty or thirty leagues from *Kingtecbing*; and hither theſe earths, or rather ſtones, are brought in an infinite number of little barks, inceſſantly paſſing up and down the river

river *Jaucheu* for that purpeſe. The *petunſes* are brought in form of bricks, having been ſo cut out of the quarries, where they are naturally pieces of a very hard rock. The white of the beſt petunſe is to border a litt'e on green.

The firſt preparation of theſe bricks, is to break and pound them firſt, into a coarſe powder with iron mallets, then in mortars with peſtles, that have ſtone heads, armed with iron, and wrought either with the hand or with mills.

When the powder is rendered almoſt impalpable, they throw it in a large urn full of water, ſtirring it briſkly about with an iron inſtrument. After the water has reſted a little while, they ſkim off from the top a white ſubſtance formed there, of the thickneſs of four or five fingers, and diſpoſe this ſcum or cream in another veſſel of water. They then ſtir again the water of the firſt urn, and again ſkim it; and thus alternately, till there remain nothing but the gravel of the *petunſes* at bottom; which they lay afreſh under the mill for a new powder.

As to the ſecond urn, wherein are put the ſkimmings of the firſt; when the water is well ſettled and become quite clear, they pour it off; and with the ſediment collected at bottom in form of a paſte, fill a kind of moulds: whence, when almoſt dry, they take it out, and cut it into pieces, which are what they properly call *petunſes*; reſerving them to be mixed with the *kauling*, in the proportion hereafter aſſigned.

Theſe ſquares are ſold by the hundred, but it is very rare to meet with them unfalſified.

The *kauling*, which is the other earth uſed in *porcelain*, is much ſofter than the *petunſe* when dug out of the quarry; yet it is this, which by its mixture with the other gives the ſtrength and firmneſs to the work.

The preparation of *kauling* is the ſame with that of the *petunſes*, except that the matter being leſs hard, leſs labour is required.

The oil or varniſh, which makes the third ingredient in *porcelain*, is a whitiſh liquid ſubſtance, drawn from the hard ſtone whereof the petunſes are formed; that which is whiteſt, and whoſe ſtains are the greeneſt, being always choſen for this purpoſe.

The manner of preparing the oil is thus: the petunſes being waſhed, undergo the ſame preparations as for making the ſquares, excepting that the matter of the ſecond urn is not put in moulds, but the fineſt part of it taken to compoſe the oil. To an hundred pounds of this matter they caſt a mineral ſtone called *ſhekau*, reſembling our alum: this ſtone is firſt heated red-hot, and thus reduced in a mortar into an impalpable powder; and ſerves to give the oil a conſiſtence; which however is ſtill to be kept liquid.

The oil of lime makes the fourth ingredient; the preparation whereof is much more tedious and circumſtantial. They firſt diſſolve large pieces of quick lime, and reduce it to a powder, by ſprinkling water on it; on this powder they lay a couch of dry fern, and on the fern another of ſlacked lime, and thus alternately, till they have got a moderate pile; which done, they ſet fire to the fern: the whole being conſumed, they divide the aſhes that remain on new couches of dry fern, ſetting them on fire as before. And this they repeat five or ſix times ſucceſſively, or even more; the oil being ſtill the better, as the aſhes are oftner burnt.

In the annals of *Feuliang*, 'tis ſaid, inſtead of fern they antiently uſed the wood of a kind of medlar-tree: and that 'twas this gave the antient *porcelains* that admirable hue, which the moderns cannot come up to for want of that wood. 'Tis certain, however, the quality of the fern and lime contribute very much to the goodneſs of the oil.

A quantity of theſe aſhes of fern and lime are now thrown into an urn full of water; and to an hundred pounds of aſhes is added a pound of *ſhekau*, which diſſolves therein. The reſt being performed after the ſame manner as in preparing the earth of the petunſes; the ſediment found at the bottom of the ſecond urn, and which is to be kept liquid, is what they call the *oil of lime*; which the *Chineſe* eſteem as the ſoul of the former oil, and which gives the *porcelain* all its luſtre. This oil is eaſily ſophiſticated by adding water to increaſe the quantity; adding, at the ſame time, proportionably of the ſame *ſhekau* to maintain the conſiſtence. Ten meaſures of oil of petunſe uſually go to one of lime. To have the mixture juſt, the two oils ſhould be equally thick.

Now to form veſſels of theſe materials.—The firſt thing is, to purify the *petunſe* and *kauling*; which, for the firſt, is done after the manner already deſcrib'd in preparing the ſquares. For the ſecond, as its ſoftneſs makes it diſſolve eaſily, 'tis ſufficient, without breaking it, to plunge it in an urn full of water in an open baſket. The dregs that remain are perfectly uſeleſs, and are emptied out of the workhouſe, when a quantity is got together.

To make a juſt mixture of *petunſe* and *kauling*, regard muſt be had to the fineneſs of the *porcelain* to be made: for the finer *porcelains*, they uſe equal quantities; four parts of *kauling* to ſix of *petunſe*, for moderate ones; and never leſs than one of *kauling* to three of *petunſe* for the coarſeſt.

The hardeſt part of the work is the kneading and tewing the two earths together; which is done

done in a kind of large baſons, or pits, well paved and cemented, wherein the workmen trample continually with their feet, relieving one another, till the maſs be well mixed, growing hard, and becomes of the conſiſtence required to be uſed by the potter.

The earth, when taken out of the baſons, is kneaded a ſecond time by piece-meal, and with the hands on large ſlates for that purpoſe; and on this preparation, in effect, it is that the perfection of the work depends; the leaſt heterogenous body remaining in the matter, the leaſt vacuity that may be found in it, being enough to ſpoil the whole. The ſmalleſt grain of ſand, nay ſometimes a ſingle hair, ſhall make the *porcelain* crack, ſplinter, run, or warp.

The *porcelain*, is formed or faſhioned, either with the wheel, like earthen ware, or in moulds. Smooth pieces, as cups, urns, diſhes, *&c.* are made with the wheel. The reſt, *i. e.* ſuch as are in relievo, as figures of men, animals, *&c.* are formed in moulds, but finiſhed with the chiſſel.

The large pieces are made at twice; one half of the piece is raiſed on the wheel by three or four workmen, who hold it till it has acquired its figure; which done, they apply it to the other half, which has been formed in the ſame manner; uniting the two with porcelain earth, made liquid by adding water to it, and poliſhing the juncture with a kind of iron ſpatula.

After the ſame manner it is that they join the ſeveral pieces of *porcelain* formed in moulds, or by the hand; and after the ſame manner they add handles, *&c.* to the cups, and other works formed with the wheel.

The moulds are made after the manner of thoſe of our ſculptors, *viz.* divers pieces, which ſeparately give their reſpective figure to the ſeveral parts of the model to be repreſented; and which are afterwards united to form a mould for an entire figure.

All theſe works made in moulds are finiſhed by the hand, with ſeveral inſtruments proper to dig, ſmooth, poliſh, and to touch up the ſtrokes that eſcape the mould; ſo that it is rather a work of ſculpture than of *pottery*. There are ſome works whereon relievo's are added, ready made, as dragons, flowers, *&c.* Others that have impreſſions in creux; which laſt are engraven with a kind of puncheons. In general, all *porcelain* works are to be ſhelter'd from the cold; their natural humidity making them liable to break when they dry unequally.

As to the *painting of porcelain*; the painting work is diſtributed among a great number of workmen: to one it belongs to form the coloured circle about the edges of the *porcelain*; another traces out flowers, which another paints: this is for waters and mountains alone; that for birds and other animals, and a third for human figures.

There are *porcelains* made of all colours, both with regard to the grounds, and to the repreſentations thereon. As to the colours of landſkips, *&c.* ſome are ſimple; ſuch are all blues, which are thoſe moſt uſually ſeen in *Europe*; others are mixed up of ſeveral teints, and others again heightened with gold.

The blue is made of lapis lazuli, prepared by burning it the ſpace of twenty-four hours, in a kiln, where it is buried up in the gravel, to the height of half a foot; when burnt, they reduce it into an impalpable powder in *porcelain* mortars not varniſhed, and with peſtles of the ſame matter.

For the red, they uſe copperas, which they call *ſaufan*; a pound of this they put in a covered crucible, in the lid whereof is left a little aperture, through which the matter on occaſion may be ſeen. The crucible is heated with a reverberatory fire, till the black ſmoak ceaſes to aſcend, and a fine red one ſucceeds it. A pound of copperas yields four ounces of red liquor, which is found at the bottom of the crucible, though the fineſt part is that uſually adhering to the lid and ſides of the crucible.

The powder of flint is likewiſe an ingredient in moſt of the other colours, *v. gr.* for green; to three ounces of tonghapeen, or ſcoria of beaten copper, they uſe half an ounce of powder of flint, and an ounce of ceruſs. Violet is made by adding a doſe of white to the green already prepared; the more green is added, the deeper is the violet. For yellow, they uſe ſeven drachms of white, and three of the copperas red.

Moſt of theſe colours are mixed up with gum-water, for application; a little ſalt-petre, ſometimes ceruſs or copperas, but more uſually copperas alone, being firſt diſſolved in the water. Indeed, for *porcelains* that are to be quite red, the colour is uſually applied with oil, *i. e.* with the common oil of the *porcelain*, or another made of the white flints.

There is alſo another red, called *blown red*, becauſe in reality applied by blowing with a pipe, one of whoſe orifices is cover'd with a very fine gauze. The bottom of this tube is lightly applied to the colour wherewith the gauze is ſmear'd; when blowing againſt the *porcelain*, it becomes all ſprinkled over with little points. This *porcelain* is very rare, and of great price.

Black *porcelain*, which they call *umian*, has likewiſe its beauty. This colour has a leaden caſt, like our metal burning mirrors; and is uſually heighten'd with gold. It is made of three ounces

of lapis lazuli, with ſeven of the common oil of ſtone; though that proportion is varied, as the colour is deſigned to be more or leſs deep. The black is not given the *porcelain* till it be dry, nor muſt the work be put to the fire till the colour be dry.

The gold is not applied till after the baking, and is rebaked in an oven for the purpoſe. To apply the gold, they break and diſſolve it in water at the bottom of a *porcelain*, till a thin gilded cloud ariſe on the ſurface: it is uſed with gum-water, and to give it a body they add three parts of ceruſs to thirty of gold.

There is likewiſe a kind of *marbled porcelain*, which is not made by applying the marbling with the pencil, but for oil to varniſh it withal, uſing that of white flints, which hatches and cuts the work with a thouſand humourous ſtrokes, in manner of moſaick work. The colour this oil gives, is a white, ſomewhat aſhy. This *porcelain* is called *ſſwiki*.

There are ſeveral kinds of *porcelain*; but they are ſuch as are rather for curioſity than uſe.

There are two kinds of ovens uſed in baking, or knealing of *porcelain*; large ones, for works that are only to come to the fire once, which is the common way; and ſmall ones for ſuch as require a double baking. The large ones are two *Chineſe* fathoms deep, and almoſt four wide. They are formed of a mixture of three earths; one whereof yellow, and common, makes the baſis; the two others are ſcarcer, and dug out of deep mines, wherein people can only work in winter. One of them called *lauton*, is a very ſtrong, ſtiff earth; the other *youto*, only.

The ſides and roof of the ovens are ſo thick, that one may lay the hand on them, when the fire is at its height, without danger of burning. At the top of the dome, which is in form of a tunnel, is a large aperture, to give vent to the flames and ſmoke, which mount up inceſſantly, as ſoon as fire is once ſet to the oven. Beſide the principal aperture, there are four or five ſmall ones around; which, by being open'd and ſhut, ſerve to augment or diminiſh the heat: like the holes in the Chymiſts furnaces, called *regiſters*. The earth, which takes up the whole breadth of the oven, is placed in front preciſely againſt the opening of the door, and is two or three feet deep, and two broad; people paſſing over it on a plank, to go into the furnace to range the *porcelain*.

As ſoon as the fire is lighted, the door is walled up: only leaving an aperture for the conveyance of wood. Laſtly, the bottom of the oven is cover'd with ſand, wherein part of the firſt *porcelain* caſes are buried. The oven itſelf is uſually placed at the extremity of a long, narrow veſtible, which ſerves in lieu of bellows, the cold air being thus driven directly in the face of each other.

Each piece of *porcelain*, of any note, is diſpoſed in the furnace in its ſeparate caſe or coffin. Indeed, as to the tea-diſhes, *&c.* the ſame caſe ſerves for ſeveral. The caſes are all of the ſame matter with the oven: they have no lids, but ſerve each other mutually, the bottom of the ſecond caſe fitting into the aperture of the firſt; and thus ſucceſſively to the top of each column. Each coffin, which is uſually of a cylindrical form, that the fire may communicate itſelf more equally to the *porcelains* incloſed, has at bottom, a little lay of very fine ſand, cover'd over with duſt of kauling, that the ſand may not ſtick to the work, and care is taken that the *porcelain* may not touch the ſides of the caſe. In the larger caſes which hold the ſmall pieces, they leave the middle vacant, becauſe *porcelain* placed there would want the neceſſary heat. Each of theſe little pieces is mounted on a little maſſive of earth, the thickneſs of two crowns cover'd with powder of kauling.

The *porcelains* are put in caſes to prevent any diminution of luſtre from the too violent effect of a naked fire.

As faſt as the caſes are filled, a workman ranges them in the cavity of the furnace; forming them into piles or columns, whereof thoſe in the middle are at leaſt ſeven feet high: the two caſes at the bottom of each column are left empty; becauſe being partly ſunk in the ſand, the fire has the leſs effect on them; and for the ſame reaſon, the uppermoſt one is left empty. In this manner is the whole cavity of the oven filled with columns, excepting that part preciſely under the grand aperture.

In ranging the caſes, they obſerve always to place the fineſt pile of *porcelain* in the center; the coarſeſt at the bottom; and thoſe that are high-colour'd, and conſiſt of as much petunſe as kauling, and wherein the waſte oil is uſed, at the mouth.

Theſe piles are all placed very near one another, and are bound together at top, at bottom, and in the middle, by pieces of earth; in ſuch manner as that the flame may have a free paſſage among them, and inſinuate equally on all ſides: in which a great part of the workman's art lies, and on which the perfection of the *porcelain* much depends. Another thing to be obſerv'd is, that an oven muſt never be ſet all together with new coffins; but half one, half the other; the old ones at the bottoms and tops of the piles, and the new ones in the middle. Indeed it were better to have all burnt in an oven a-part, ere they come to be uſed for *porcelain*; as was antiently done.

When

When the oven is filled, they wall up the door; only leaving a little aperture for the throwing in little pieces of wood, a foot long, but very ſlender to keep up the fire. It is then heated by degrees, for the ſpace of a day and night; after which two men, who relieve one another, continue to throw in wood without any interruption. To know when the *porcelain* is baked enough, they open one of the leſſer holes of the oven, and with a pair of tongs take off the lids of one of the piles. If the fire appears very briſk and clear, and the piles equally inflamed; and eſpecially if the colours of the *porcelains* that are uncover'd, dart forth a noble luſtre; the action is ſufficient, they diſcontinue the fire, and wall up what remained of the door of the furnace.

If the oven be only filled with ſmall *porcelains*, they take them out twelve or fifteen hours after the fire is extinct: if it be filled with larger, they defer opening it for two or three days. In this the modern practice differs from the antient; wherein the door was not open'd till aftertten days for the large pieces, and five for the ſmall ones.

The *Chineſe* make another kind of *porcelain*, which they paint and bake twice; and for this ſecond baking they have a kind of little ovens on purpoſe. When very ſmall, they are made of iron; otherwiſe of a kind of bricks an inch thick, a foot high, and half a foot broad, made of the ſame earth with the *porcelain* caſes. The biggeſt of theſe ovens does not exceed five foot in height, and three in diameter; and being made much in form of bee-hives, the bricks are arched a little to form the curvity the bettet. The hearth is of earth, half a foot high, formed of two or three ranges of bricks, and on this maſſive is the oven built. Around the oven, at the diſtance of about half a foot, is raiſed a ſhell of common bricks, joined to the oven itſelf by a kind of arcboutant of earth, which ſerves to ſtrengthen it. They uſually build four or five of theſe ovens at equal diſtances from each other. At the bottom of the ſhell are holes to give air to the fire when lighted: at top is an aperture which they cover up with a piece of the baked earth, when the *porcelains* are laid in the oven.

The *porcelains* here are not incloſed in coffins; as in the common ovens; the oven itſelf ſerving that purpoſe, and being ſo exactly cloſed, that they receive no other impreſſion of the fire, but that of the heat of the charcoal diſpoſed in the hearth, at the bottom of the oven, as well as at top of the vault, and the interval between the oven and the ſhell, or brick-wall.

To prepare the *porcelains* for a ſecond baking, they muſt have had their varniſh in the common manner, and have paſſed the great oven. In this ſtate they are painted with various colours, after which, without giving them any new varniſh, they are ranged in piles in the little oven, ſetting the little ones over the larger in form of pyramids.

This ſecond baking is ſometimes intended to preſerve the luſtre of the colours the better, and at the ſame time to give them a kind of relievo. But more uſually its deſign is to hide defective places, by covering them over with colours: but the artifice is eaſily found out by paſſing the hand over them.

When the workman judges his *porcelains* enough baked, he takes off the piece that covers the aperture; and if the works appear glittering, and the colours glowing, he takes out the charcoal; and when the oven is cold, the *porcelain* too.

Porcelain, is made chiefly, ſome ſay wholly, at *Kingtechíng*, a large town in the province of *Kyangſi*. There is ſome indeed made in the province of *Canton* and *Fokyen*; but is of little account, being far inferior in beauty and value to the *porcelain* of *Kingtechíng*. That of *Fokyen* is perfectly white, without either gloſs or painting. Attempts have been made to remove the manufacture from *Kingtechíng* to *Pekin*, and other places, but in vain; the *porcelain* made in the new manufactories never coming up to that of the old: ſo that *Kingtechíng* has the honour of ſupplying the greateſt part of the world with this commodity. Father *Du Haldé* aſſures us, that even the *Japaneſe* come to *China* for it.

Porcelain makes a very curious article in commerce, and even natural hiſtory. Its manufacture has paſſed, till of late years, for a myſtery in *Europe*; and that in ſpite of all the endeavours of the Jeſuit Miſſionaries (to whom *Europe* is indebted for ſo many curious and uſeful diſcoveries) to penetrate into the ſecret. The veil however, was at length drawn; and in a letter of Father *d'Entrecolles* to Father *Orry*, from *Jauchen*, dated *September* the 1ſt, 1712, and afterwards publiſhed in *French*, the whole proceſs is deſcribed in all its circumſtances; and ſuch as it is given here word for word, from the *French*.

The *French* ſoon made all the uſe they could of this diſcovery of F. *d'Entrecolles*, in attempting to imitate *porcelain*. The firſt Eſſays made at *Rouen* ſucceeded tolerably well; and are now carried to ſuch a point in the manufactories at *Paſſi* and *St. Clou*, near *Paris*, that the French *porcelains* want nothing to make them of equal value with the *Chineſe*, but to be brought five or ſix thouſand leagues. In effect, for the fineneſs of the grain of the matter, the beauty and turn of the veſſels, the exactitude of the deſign, and the luſtre of the

the colours, the *French* are not much behind the *Chineſe*.

The like may be ſaid of the *porcelain* manufactures at *Bow* and *Chelſea*, near *London*, and in other parts of *England*.

There is alſo a beautiful manufacture of *porcelain* at *Miten*, the capital of *Miſnia*, in *Saxony*, which the Baron *de Polnitz* aſſures us, produces *porcelains* painted and enamelled in ſuch perfection, that they are more beautiful, as well as dearer, than thoſe of *China* itſelf.

I am of opinion, that the beſt *Engliſh* chalk, and the whiteſt, well beaten, ſifted very fine, to free it of all ſandy, or other heterogeneous matter, and mixed afterwards with a ſixth part of quick-lime, the whole mixture buried in a hole out of which clay has been dug, and left there to ferment, and incorporate for two or three years, would produce a matter very proper to imitate *porcelain*.

Having been deſired by ſome friends to give them a ſecret to join *porcelain* when broke: I muſt inform them, that they muſt take the largeſt ſnails they can find in their ſhells; and take the tail of theſe ſnails, which they'll find at the bottom of the ſhell, white like a roll of fat; diſſolve that fatty matter in the beſt brandy, ſo as to form of it a kind of thick glue, and beſmearing the edges of the broken china with that glue, join the pieces, thus ſmear'd, together, and put them to dry from the ſun. This is a ſecret worth notice, and *porcelain* thus joined, appears, as if it was only flawed. Flint and other glaſſes, may alſo be joined with the ſame matter, and in the ſame manner.

PRINTING.

PRINTING is the art of taking impreſſions on paper, vellum and ſilk, from either ſeperate types, characters or figures; or from plates of metal, or blocks of wood.

The *printing* with ſeparate types is peculiar to books, &c. and is diſtinguiſhed by the name of *letter-preſs-printing*. The art of printing from plates is called *rolling-preſs-printing*. And that from wood is commonly ſtiled *block printing*: and though the letter-printer uſes wood devices for head and tail pieces, facts and extraordinary large capital letters, and chaces them up with his metal types: this ſort of printing is generally confined to callicoes, linnens, &c. Therefore I ſhall confine this treatiſe to the *letter-preſs* only.

Who the firſt inventors of the *European* method of *printing books* were, in what city, and what year it was ſet on foot, are queſtions long diſputed among the learned. In effect, as the Grecian cities contended for the birth of *Homer*, ſo do the German printers for that of printing. *Mentz*, *Haerlem*, and *Straſburg*, are the warmeſt on this point of honour, and theſe are left in poſſeſſion of the queſtion, which is not yet decided: though it muſt be owned that *Mentz* has always had the majority of voices.

John Guttenburg, and *John Fauſt* of *Mentz*; *John Mentzel* of *Straſburg*, and L. *John Koſter* of *Haerlem*, are the perſons to whom this honour is ſeverally aſcribed, by their reſpective country-men; and they have all their advocates among the learned. However, their firſt eſſays were made on *wooden blocks*, after the *Chineſe* manner. The book at *Haerlem*, the *vocabulary* called *Catholicon*, and the pieces in the *Bodleian* library, and that of *Bennet-college*, are all performed in this way; and the impreſſion appears to have been only given on one ſide of the leaves; after which the two blank ſides were paſted together. But they ſoon found the inconveniencies of this method, and therefore bethought themſelves of an improvement; which was by making ſingle letters diſtinct from one another, and theſe being firſt done in wood, gave room for a ſecond improvement, which was the making them of metal; and, in order to that, forming moulds, matrices, &c. for caſting them.

From this ingenious contrivance we ought to date the origin of the preſent art of printing, contradiſtinguiſhed from the method practiſed by the *Chineſe*. And of this *Schoeffer*, or *Schefter*, firſt ſervant, and afterwards partner and ſon in-law of *Fauſt*, at *Mentz*, above-mentioned, is pretty generally allowed to be the inventor; ſo that he may properly be reckoned the firſt printer, and the *Bible* which was printed with *movable letters* in 1450, the firſt printed book; the next was *Auguſtine de civitate Dei*, then *Tully's Offices*, printed about the year 1461. In theſe books they left the places of the initial letters blank, and gave them to the illuminers to have them ornamented and painted in gold and azute, in order to render the work more beautiful, and, as ſome think, to make their books paſs for manuſcripts.

From *Mentz*, the art of printing ſoon ſpread itſelf throughout a good part of *Europe*; *Haerlem* and *Straſburg* had it very early; which, as the current of authors repreſent it, occaſioned their pretending to the honour of the invention.

From

From *Haerlem* it paſſed to *Rome* in 1467; and into *England* in 1468, by means of *Tho. Bourchier*, archbiſhop of *Canterbury*, who ſent *W. Turner*, maſter of the robes and *W. Caxton*, merchant, to *Haerlem* to learn the art. Theſe privately prevailing with *Corſeilles*, an under-workman, to come over, a preſs was ſet up at *Oxford*, and an edition of *Ruffinus* on the creed was printed the ſame year in *octavo*.

From *Oxford*, *Caxton* brought it to *London* about the year 1470, and the ſame year it was carried to *Paris*.

Hitherto there had been nothing printed but in *Latin*, and the vulgar tongues; and this firſt in *Roman* characters, then in *Gothic*, and at laſt in *Italic*: but in 1480, the *Italians* caſt a ſet of *Greek* types, and they have alſo the honour of the firſt *Hebrew* editions which were printed about the ſame time with the *Greek*. Towards the end of the ſixteenth century there appeared various editions of books in *Syriac*, *Arabic*, *Perſian*, *Armenian*, *Coptic* or *Egyptian* characters, ſome to gratify the curioſity of the learned, and others for the uſe of the *Chriſtians* of the Levant.

Out of *Europe*, the art of printing has been carried into the three other parts of the world: for *Aſia*, we ſee impreſſions of books at *Goa*, and in the *Philippines*; at *Morocco*, for *Africa*; at *Mexico*, *Lima*, *Philadelphia*, *New York*, *Boſton*, &c. for *America*. The Turks, indeed, rigorouſly prohibit printing throughout their empire, as imagining that the too frequent communication with books might occaſion ſome change in their religion and government; yet the *Jews* have ſeveral editions of their books printed at *Theſſalonia*, and even at *Conſtantinople*.

And Sir *Paul Rycaut* the *Engliſh* ambaſſador at the Port had the articles of peace, &c. between his country and the *Turks* printed at *Conſtantinople* alſo in the year 1660 in 4to, and in the *Engliſh* tongue.

To fit up a printing houſe, we muſt have ſeveral fonts of different characters, or types, preſſes, and caſes divided into little cells or boxes of different ſizes, to contain the types; *compoſing ſticks*, *galleys*, *chaſes*, *rules*, *ſtones* for impoſing, *head-ſticks*, *gutter-ſticks*, *ſide-ſticks*, *foot-ſticks*, *quoins*, *plainers*, *riglets*, *ciſterns*, *ink*, *paper*, &c.

Characters or *types* have different names, according to their ſizes or bodies, *viz. pearl*, *nonpareil*, *brevier*, *long primer*, *ſmall pica*, *pica*, *engliſh*, *great primer*, *double pica*, *two-lined engliſh*, and *French canon*, we ſhould have in our *printing-houſe*, together *Saxon*, and *Greek* types, *&c.*

We call a ſet of any of theſe ſizes a *font*, which includes current letters, capitals, numeral letters, points, quadrats, ſpaces, *&c.*

Beſides the ſeveral kinds of characters and letters above-mentioned, we muſt have rules for *black lines*, *borders*, and *head* and *tail pieces*, accommodated to the ſeveral kinds of letters.

The *rules* for blank lines are of braſs, and made exactly the height of the letter.

The *borders* are a kind of ornaments in form of long bars, ſerving for the diviſions of books, chapters, *&c.* their depth is proportioned to the letter, and their length adjuſted to the page, for being compoſed of ſeveral moveable pieces, it is eaſy lengthening or ſhortening them.

The *head* and *tail-pieces* cut either in wood or pewter, are compartments uſed at the beginnings and endings of books.

The initial letters are ſometimes cut in wood and figured; ſometimes caſt like the other characters.

Having purchaſed our *fonts* of letters, and ſent them to our intended *printing-houſe*, our next care is to have a *printing-preſs* (repreſented in the *miſcellaneous* plate) which is a very compleat machine: its two principal parts, each whereof conſiſts of ſeveral others, are the *body* of the *preſs*, which ſerves to give the pinch or ſtroke for the impreſſion; and the carriage, on which the form is laid to undergo the ſame.

The *body* conſiſts of two ſtrong cheeks, placed perpendicularly, and joined together by four croſs pieces or planks.

The firſt plank, called the *cap* of the *preſs*, is fixed, and ſerves to keep the two cheeks together at the due diſtance a-top: the ſecond called the *head* is moveable; being ſuſtained by two iron pins or *long bolts*, that paſs the *cap*: in this plank is fixed a female ſcrew, or *worm*, with a *braſs nut*, ſuſtained by two *ſhort bolts*, which keep it up: the third plank called the *ſhelves*, ſerves to keep ſteady a part called the *boſe*, in which the ſpindle (to be ſpoken of hereafter) is incloſed: the fourth plank, called the *winter*, is moveable; it bears the carriage, and ſuſtains the effort of the *preſs* beneath, as the head does above; each giving way a little, the one upwards, the other downwards, to make the pull the eaſier.

The *ſpindle* is an upright piece of iron, pointed with ſteel, of different dimenſions, having a male ſcrew, which goes into the female of the head, about four inches. Through the eye of this ſpindle is rivetted the *bar*, by which the preſs-man works the preſs.

The lower part of the ſpindle paſſes through the ſhelves, being incloſed in a ſquare wooden frame, called the *boſe*; and its point works into the plug, fixed in a braſs pan ſupplied with oil; which pan is fixed to an iron plate, let into the top of the platten,

ten. The preſs-man, then, by turning or pulling the bar fixed in the eye by an iron key, preſſes upon a ſquare ſmooth piece of wood, called the *platten*, and enables it to compreſs the form cover'd with the paper, *tympans*, and its blankets, which in order thereto, are brought under the *platten*.

At each corner of the *boſe* is an iron hook faſtened to thoſe at each corner of the platten, with cords or packthread, very exactly.

The *carriage*, which makes the ſecond principal member of the preſs, is placed a foot below the platten, having its fore part ſupported by a wooden prop, called the *fore ſtay*, while the other reſts on the winter. On this carriage, which ſuſtains the plank, are nailed two long iron bars or *ribs*; and on the plank are nailed ſhort pieces of iron or ſteel, called *cramp-irons*, equally temper'd with the ribs, and which ſlide upon them when the preſs is turned in or out.

Under the carriage is fixed a ſmall piece of iron, called the *ſpit*, with a double wheel in the middle, round which leather *girts* are faſtened, nailed to each end of the plank. To the outſide of the *ſpit* is fixed a handle, or rounce, by which the preſſman turns the preſs in or out at pleaſure.

Upon the plank is a ſquare wooden frame or coffin, wherein is incloſed a marble or poliſhed ſtone, for the form to be laid on. To this coffin are faſten'd leather ſtay-girts, one to each ſide; which being again faſten'd to the cheeks of the preſs, prevent the plank from running too far out, when drawn from under the platten. On the fore part of the plank is a gallows, which ſerves to ſuſtain the tympans, when taken from off the form.

On the front of the coffin are three frames, much alike, though ſerving for different purpoſes, *viz.* the two tympans and friſket: the *tympans* are ſquare, made of three ſlips of very thin wood, and a top, of a ſlip of iron, ſtill thinner, called a *head-band*: that called the outward *tympan*, is faſten'd with iron joints to the coffin. They are both cover'd with parchment; and between the two are placed blankets, which ſerve to make the impreſſion of the platten, upon the ſurface of the letters more equal, as alſo to prevent the letters from being bruiſed by the force of the preſs. The *friſket* is all of iron, very thin, faſten'd a top to the great or outward tympan, and ſuſtained by a ſlip of wood hanging from the cieling, when open'd to take out the printed ſheets, and put in others. It is alſo covered with parchment or paper, cut in the neceſſary places, that the ſheet, which is between the great tympan and friſket, may receive the ink, and that nothing may hurt the margin. On the parchment of the great or outward tympan it is, that the blank ſheet is laid to be printed.

To regulate the margin, and make the lines and pages anſwer each other when printed on the other ſide, in the middle of the wood, in the ſides of this tympan, are two iron points, which make two holes in the ſheet, to be placed on the ſame pins, when the ſheet is returned for an impreſſion on the other ſide, called the reiteration.

Our *preſs* fixed, we'll range in order the *caſes*, which are to contain our letters, placing two of them, one over the other; the upper one is divided into 98 boxes, to contain the *capitals*, *ſmall capitals*, *accented letters*, &c. and the lower one divided into 54, to contain the *common running letters*, with the *points*, *commas*, *quadrats*, &c. placing each caſe a little ſlope, like a reading deſk.

In the boxes of theſe caſes, our letters muſt be diſtributed, according to the order of the alphabet; together with *ſpaces*, *quadrats*, *quotations*, &c.

The *printing-houſe* thus in order, we muſt ſeek next for a good ſet of workmen, *viz.* *compoſitors*, and *preſs-men*; *compoſitors* to range and diſpoſe the letters into words, lines, pages, &c. according to the copy delivered them by the author; and *preſs-men* to apply ink upon the ſame, and take off the impreſſion.

The *compoſitor* moſt commonly works ſtanding; and muſt place himſelf againſt the middle of the caſe; holding his *compoſing-ſtick*, (Plate *ibid.*)

The *compoſing-ſtick* conſiſts of a plate or ſlip of iron, braſs, wood, &c. more or leſs broad, and contrived ſo as to be made more or leſs long, according to the width of the page, and the number of lines to be compoſed in it. From the right of this plate ariſes a ledge, about half an inch high, running the whole length of the plate, and ſerving to ſuſtain the letters, the ſides of which are to reſt againſt it; from the ſaid plate likewiſe ariſe three other leſſer pieces, two of which are contrived to ſlide along it, that ſo the two pieces may be either approached or withdrawn at pleaſure, to adjuſt the length of the line to the meaſure intended.

Add, that where marginal notes, references, &c. are required in a work, the two ſliding pieces are opened in the compoſing-ſtick, to a proper diſtance from each other.

Ere the workmen proceeds to compoſe, a *rule* or thin ſlip of braſs plate, cut to the length of the line, and of the ſame height as the letter, is placed in the compoſing-ſtick againſt the ledge thereof, for the letters to bear immediately againſt.

Things thus prepared, the compoſitor having the copy (which is what the author has wrote) laying before him, and the ſtick in his left hand, with the right he picks up the letters, ſpaces, &c. and places them againſt the rule; while with the thumb of the left he places them cloſe to the upper ſcrew,

or

or cheek; and thus keeps them ſteady, while the other hand is conſtantly employed in ſetting in more letters: the whole being performed with ſuch expedition and addreſs, not eaſy to be imagined.

A line being thus compoſed, if it ends with a word or ſyllable, and fills the meaſure, there needs no further care; otherwiſe more ſpaces are to be put between the ſeveral words to juſtify the lines, *i. e.* to make the meaſure quite full, ſo that every one may end even; and thus he proceeds to another line.

The *ſpaces* here uſed are a ſort of blanks of the like dimenſions with the letters, but leſs high; and whoſe faces therefore, when ſet, do not appear, nor give any impreſſion. They are of ſeveral kinds, according to the dimenſions of the whites, or intervals to be made by them, *viz.* quadrats, to fill up a break at the end of a paragraph, or the like; *m* quadrats, which are ſquare, and of the thickneſs of an *m*, ſerving to make the diſtance after a period, or between ſentence and ſentence; *n* quadrats, of the thickneſs of an *n*, to be placed after the colons, ſemi-colons, and comma's; and thick or thin ſpaces, to be uſed between the words in juſtifying, as above.

For marginal notes, in the ſpaces reſerved for them, between the two ſliding pieces of the compoſing-ſtick, are put little quadrated pieces of metal, called *quotations* (already mentioned) which are juſtified by other ſmaller pieces; a ſlip of ſcale-board being placed from the top of the page to the bottom, to keep the note and text at a due diſtance.

The firſt line thus compleatly juſtified, the *compoſitor* advances to the next; in order to which he moves the braſs rule from behind the former, and places it before it, and thus compoſes another line againſt it, after the ſame manner as the former.

The *compoſitor* having thus ſet the proper number of lines in his ſtick, *viz.* four, five, ſix, or more, and emptied them thus out into the galley; he again fills and empties, as before, till a compleat page be formed, remembring at the bottom of every page to ſet a line of quadrats, and at the end thereof the firſt word of the page enſuing, for a catch-word; and if it be the firſt page of the ſheet, one of the letters for a ſignature.

The *galley* is a flat wooden inſtrument, in form of a long ſquare; of a length and breadth proportionable to that of the page: it conſiſts of two parts, the upper called the *ſlice*, whereby the pages of large volumes, when compoſed, are ſlidden upon the ſtone; the other, called the *coffin*, which is the body of the *galley*, is ledged on three ſides, to contain the ſlice; the inner ledge not to exceed half an inch in height, that the compoſed page riſing above it by one half the height of the letter, may be tied up or bound down, and removed without danger.—This *galley* is placed at the top of the caſe, and detained by a wooden pin from ſliding down the boxes.

The page then compoſed and ranged in the galley, he ties it down therein with a cord of packthread, and ſets it by; and proceeds to the next till the number of pages in the ſheet be compoſed: which done, he carries them to the impoſing or correcting-ſtone, there to range them in order in a *chaſe*, which they call *impoſing*.

The *chaſe* is a rectangular iron frame of different dimenſions, according to the ſize of the paper to be printed on; having two croſs pieces of the ſame metal, called a *long* and *ſhort croſs*, mortiſed at each end, into the frame, ſo as to be taken out occaſionally.—By the different ſituations of theſe croſſes, the *chaſe* is fitted for different volumes; for quarto's and octavo's one traſverſes the middle lengthwiſe, ſo as to interſect in the center; which is the moſt cuſtomary ſituation: for twelves and twenty-fours, the *ſhort croſs* is ſhifted nearer to one end of the *chaſe*: for folio's, the *long croſs* is left entirely out, and the ſhort one placed in the middle; and for broadſides, or ſheets printed on one ſide only, both *croſſes* are ſet aſide. To dreſs the chaſe, or range and fix the pages therein, they make uſe of a ſet of furniture, conſiſting of riglets, or ſlips of wood of different dimenſions, and of about half an inch high, that they may be lower than the letters: ſome of theſe are placed at the top of the pages, called *head-ſticks*; others between them to form the inner margin, called *gutter-ſticks*, others at the ſides called *ſide-ſticks*; and others at the bottom, called *foot-ſticks*.

The pages then placed in order on the ſtone, the *chaſe* is put over them, and the riglets applied between the letter and the chaſe, in the poſition above-mentioned; the whole is locked up by means of ſmall pieces of wood, cut in the wedge-form, called *quoins*, which are driven with a mallet and ſhooting-ſtick, to a ſufficient tightneſs.

Before the form be quite locked up, they dreſs down the ſame, by paſſing a ſmooth piece of wood, called the *plainer*, over the letters; to make their ſurfaces ſtand flat and even; and when locked up, they ſhake it to ſee that nothing ſtir.

In this condition the work is called a form, containing more or fewer pages, according to the volume.

As there are two forms required for every ſheet, when both ſides are to be printed, it is neceſſary they be exactly of the ſame length and breadth, *i. e.* the correſponding riglets, head-ſticks, *&c.* are to be equal in both forms, that the pages may fall ex-

actly on the back one of another, which is called *regiſter*.

The form thus finiſhed is committed to the preſs-men, to pull a proof there; in order to rectify the errors which may have ſlipped the compoſitor's attention; which are in a greater or leſſer number, according as the *compoſitor* has been more or leſs careful in his compoſition; or has a greater or leſſer capacity.

The proof pull'd is carried to the *corrector* of the preſs, who ought to read it over with a great deal of attention, and compare it carefully with the copy, in order to rectify all the miſtakes; which is ſeldom done as it ought to be.

The corrections are placed on the margin of each page, right againſt the line where the faults are found. There are different characters uſed to expreſs different *corrections*, *D* or ℘ *dele*, for any thing to be effaced or left out. When any thing is to be inſerted, the place is marked in the line with a caret ʌ, and the inſertion added in the margin. When a word, ſyllable, *&c.* is to be alter'd, it is eraſed out of the proof, and that to come in its room written in the margin; always obſerving, if there be ſeveral in the ſame line, that they be ſeparated by little bars or ſtrokes, | if a ſpace be omitted, its place is marked with a caret, and the thing expreſſed in the margin ⁂: if a letter be inverted, it is expreſſed in the margin with ↄ: if any thing be tranſpoſed, it is marked thus; *the ſhorteſt are the | follies | beſt*; for, *the ſhorteſt follies are the beſt*: and in the margin is added *tr* in a circle. If *Roman* characters are to be changed for *Italick*, or *vice verſa*, a line is drawn under them *thus*, and *Roman* or *Italick* added in the margin.

The *proof* or *ſheet* corrected, is delivered back to the compoſitor, that he may rectify in the form the miſtakes marked by the corrector; in order to which he goes with his compoſing-ſtick to the caſe, to take the letters he thinks neceſſary for this operation; then comes to the form, which he unlocks on the correcting-ſtone, by knocking out or looſening the quoins; and ſpreading his corrected proof ſo, as that the line thereof range with the reſpective ones of the metal; by running his eye along both, he eaſily ſpies where the corrections are to be made; according to which, he proceeds to pick out the faulty letters, points, *&c.* with a ſharp-pointed ſteel bodkin, and puts others in their places.

The form corrected, and locked again by the compoſitor, is delivered for good to the preſs-man, who are to work it off; who, to be ready for this operation, has took care to prepare his ink, preſs, and paper for it.

The *ink* for printing is of two kinds, black and red: the laſt occaſionally uſed in title-pages, kalendars, *&c.* the firſt for the body of the book.

To fit the *paper* for uſe, it muſt be firſt wet or moiſtened, by dipping ſeveral ſheets together in the water: theſe are afterwards laid in a heap over one another; and to make them take the water equally, are all preſſed cloſe down with a weight a-top. As to the degree of wetting, it muſt be according to the quality of the paper, and the ſize of the letter; ſmall letters, and ſtiff paper, requiring moſt wetting, But the paper ought not to be wet long before it is uſed; otherwiſe it would be covered with a great number of yellow ſpecks.

The paper, being fit for uſe, the ink prepared, and the form placed on the ſtone in the preſs, the preſs-man goes to work; and for the greater diſpatch, ſometimes three perſons are employed in this operation, one to beat the form with the ink, another to lay the blank-ſheet on the outward tympan, and work the preſs, and another to take off the ſheet, when printed; which operator they call the *fly*; the firſt thing done is beating the form with ink, by means of balls, which are a kind of wooden funnels, the cavities whereof are filled with wool, covered with leather nailed to the wood. One of theſe the operator takes in each hand, and applying them on the ink-block, to charge them with ink, he rubs them againſt one another to diſtribute the ink equally; and at laſt ſmears over the form, by beating or dabbing them ſeveral times over the whole face thereof; taking care to do it ſo evenly, that no part thereof may be left unſmeared; whence would enſue fryars, as they call them, *i. e.* places in the ſheet left unprinted, which is a very great detriment to it, a ſcandal to the operator, and his maſter, and a baulk to the reader: while he is beating the form, the preſs-man lays the white ſheet on the tympan; and the form ſmeared, he brings the tympans and friſket down from the gallows upon it; and advancing the plank under the platten, by means of the ſpit-handle or rounce, gives two ſtrokes or pulls with the bar, and with an equal ſtrength, that the ſheet may be printed every where equally; and with the ſame handle turned the contrary way, brings back the plank, ſo takes off the printed ſheet, and put on a freſh one; the form being beaten with ink every time a freſh ſheet is put on; and this he repeats till he has taken off the full number of ſheets the edition is to conſiſt of.

One ſide of the ſheet being thus printed, it is remanded to the preſs for the other; and ſo diſpoſed, as that the iron points paſs through the holes already made in the ſheet.

The number of ſheets of the edition being compleat

pleat, and the form to be ſeparated, to reſtore the letters into the caſes, they firſt waſh it in lye to take out the remains of the ink, ſcrubbing it with a bruſh, and then waſh it with fair water. This done, it is carried to a board, on which it is unlocked, and the furniture, *i. e.* the ſticks, *&c.* taken off to diſengage it from the chaſe. Then the compoſitor taking up ſeveral lines at once upon a litttle wooden ruler, he replaces each letter in its proper box, to be again uſed in the remainder of the impreſſion.

Books are printed in *China* from wooden planks or blocks, cut like thoſe uſed in *printing* of callico, paper, cards, *&c.* among us.

Theſe blocks are made of a ſmooth, firm, cloſe wood, and of the ſize of the leaf required. On the face-ſide they glue a paper, upon which ſome able penman draws out the ſeveral letters and characters with a *Chineſe* pen, which is a kind of pencil. This is the principal part of the work, and that whereon the ſucceſs of the reſt depends.

When finiſhed, the block is put in the hands of a ſculptor, or cutter in wood; who following the ſeveral ſtrokes of the writer with his gravers, and other ſharp little inſtruments, makes them all appear in relievo on the wood.

When the carving or cutting is finiſhed, they moiſten what remains of the paper, and rub it gently off.

The ink they uſe in *printing* is the ſame with the common *Chineſe* ink, wherewith they alſo write; and is made of lamp-black mixed up with oil.

Their preſs reſembles our rolling-preſs, much more than the letter-preſs.

PYROTECHNY.

PYROTECHNY, πυροτεχνια, is the art of fire, or a ſcience, which teaches the management and application of fire in ſeveral operations, either *military* or *chymical*.

Chymical pyrotechny is the art of managing, and applying fire in diſtillations, calcinations, and other operations of chymiſtry, of which at large in *chymiſtry*.

Military pyrotechny, is the doctrine of artificial fire-works, as *rockets*, *ſtars*, *ſerpents*.

A ROCKET is an artificial fire-work, conſiſting of a cylindrical caſe of paper, filled with a compoſition of certain combuſtible ingredients; which being tied to a ſtick, mounts in the air to a conſiderable height, and there burſts.

Beſides the *rocket* here defined, which is properly called the *ſky-rocket*, there is another, which from the ſphere it moves in, the water is denominated *water-rocket*.

The compoſition wherewith *rockets* are filled, is made in the following manner.

You muſt take the biggeſt gun-powder, bruiſe it on a table, with a wooden muller, and paſs it afterwards through a very fine ſilk ſierce, take ſixteen ounces thereof, and put it by itſelf: then you'll bruiſe charcoal likewiſe, made of willow, or white wood, and paſs it afterwards through a ſierce of horſe-hairs, a little coarſer than that of ſilk. You'll mix with your hands four ounces of this coal, with your ſixteen ounces of powder, and paſs the mixture four or five times thro' a horſe-hair ſieve, much coarſer than the other; and every time you'll have paſſed it you'll ſtir it with the hand. This compoſition well mixed and incorporated together, muſt be kept in a proper veſſel for uſe.

You'll try one of your *rockets* charged with this compoſition; if it does not aſcend there is too much charcoal, and the compoſition is too weak-therefore it muſt be ſtrengthned with an ounce of gun-powder pulverized; and if it burſts in aſeending into the air (as it often happens when the rockets have not been tried) the compoſition is too ſtrong, and an ounce of charcoal muſt be added to it, or more, according to the prudence of the artificer.

Several artificers are of opinion, that *ſky rockets* can be made with the following compoſitions, in proportion to their bigneſs; ſome of them weighing, when filled and equipped, as far as twelve pounds, as it is explained in the following tables.

Doſe to make ſky-rockets.

Compoſition for a Mould of 2 lb.	*Compoſition for a Mould of 1 lb.*	*Compoſition for a Mould of ½ lb.*	*Compoſition for a Mould of 4 oz.*	*Compoſition for a Mould of 2 oz.*
Powder 2 lb.	—— 1 lb.	—— 20 oz.	—— 5 oz.	8 o 9 oz.
Salt-petre 1 lb.	—— 12 oz.	—— 12 oz.	—— 1 oz.	½ of an oz.
	—— 2 oz.	—— 1 oz.	—— ½ oz.	
Sulphur 5 oz.		—— 3 oz.	—— ½ oz.	½ an ounce or 1 ounce.
Charcoal 40z.				
Iron-ſlings 20z				
The mould has 9½ Inches in Height.		The mould has 8 ½ Inches in Height.	The Mould has 7 Inches in Height.	The mould has 4½ In. in Heightt

As an additional ornament to *rockets*, it is uſual to furniſh them either with ſtars, or with ſerpents, or ſparks, or with a ſhower of rain, which take fire when the *rocket* burſts; and ſometimes little rock-

ets are incloſed in great ones, to take fire when the great one is at its greateſt height.

To make *ſtars for rockets*.—Mix three pounds of ſalt petre, with eleven ounces of ſulphur, three ounces of beaten gun-powder, and ten of antimony. Moiſten the maſs with gum water, and form them into little balls of the ſize of filberds; drying them well either in the ſun or an oven. When dry, incloſe a nember of them in the conical cap of the *rocket*.

As to the method of making *water-rockets*; make a *rocket* after the uſual manner, excepting in the number of choaks. Let its diameter be equal to that of a leaden ball of two or three inches diameter, and let it be bored to a third part of its height. Incloſe the *rocket* in a hollow perpendicular cylinder, which ſmear over with melted pitch or wax, that it may reſiſt the moiſture.

The weight of the *rocket* is to be ſo proportioned to that of the water, that the whole cylinder may be immerged. Some inſtead of a cylinder uſe a truncated cone, or even a ſpheroid; and ſome hang a weight to the end where it is lighted.

To make a rain of fire for the *rockets*, take equal quantity of ſulphur, ſalt-petre, and gunpowder, beat well each ingredient by itſelf; and melt, afterwards, the ſulphur in a glazed earthen pot, or in a copper pot which is beſt; when melted, put the ſalt-petre by little and little into it, ſtirring continually the matter; and laſtly the powder; this muſt be done over a very litttle fire, leſt it ſhould catch the mixture, while you ſtir it. Thoſe three ingredients being well incorporated together, pour the mixture on paper, or board, where it will grow hard, and when you'll want to make a rain of fire, you muſt break it into ſmall pieces, and mix it with the powder of the cracker of your *rocket*.

To make a *rocket* to run along a cord. Take two *ſky-rockets*, of the bigneſs of thoſe firſt in order in our table; but without a cap, or any other apparatus, only as they come out of the mould; join thoſe two *rockets* together ſide-wiſe, the upper end of the one turned towards the lower end of the other, ſo that the ſtopple, which comes out of the maſſive of the one, enters the choak of the other; and paſte paper over it, leſt the violence of the effort ſhould part them; taking care, likewiſe, to ſtop with wet and paſted paper, the end of the maſſive, which is to fire laſt.

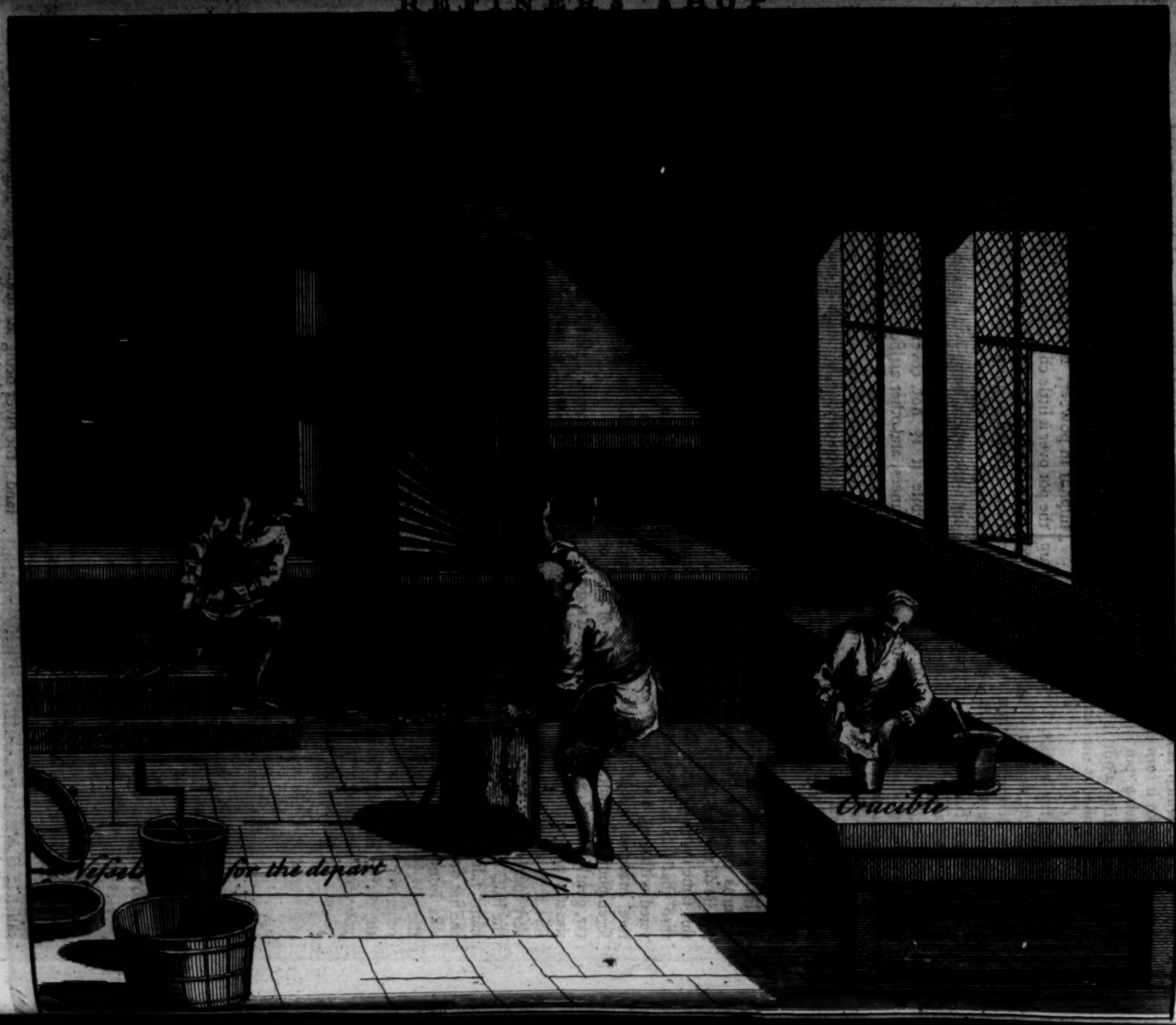
Thoſe two *rockets* thus diſpoſed, an empty cylinder is faſten'd to them very tight in three places, and the cord run afterwards through it.

The *rocket*, which is lighted firſt, runs along the cord, from the end it departed to the other end; and when exhauſted, the other takes fire, and returns back the ſame way.

To make a *ſerpent*, you muſt roll upon an iron rod, or round ſtick, two gaming-cards, one over the other, which muſt be cover'd with a paper, ſo that the paper appears always a top, and cards inſide: it will be neceſſary to wet a little the cards to make them more tractable; but they are not to be uſed before they are dry; paſting paper afterwards, which cover them all its length, to faſten it. You introduce the baſe of the mould into the *ſerpent*, and choak it at that place, with a pack-thread greaſed with a little ſoap; and tie it afterwards with thread; then you put the mould over the *ſerpent*, which thereby is incloſed in it; charging it afterwards by means of a quill, with the ſame compoſition the *rockets* are made of; filling half the *ſerpent* firſt, and then ramming the charge with the ſame iron rod, the cylinder has been rolled upon; and having put a grain of vetch over the charge, you fill up the *ſerpent*, with whole gun-powder, leaving a place empty a-top, to thruſt in a ſtopple of chew'd paper, which muſt be rammed down with the iron-rod: the paper being rammed down, and a little ſpace left empty over it, you choak likewiſe the *ſerpent* at that place, and tie it with a thread, as you have done the other end; with this difference, that this end is quite cloſe, and the other has preſerved the aperture made to it, by the ſpike thruſt into it at firſt; this empty place is primed afterwards with gun-powder, bruiſed and mixed with water.

For a GIRANDOLA it muſt be made in form of a wheel, with ſix faces: the ſpokes of the wheel to be of a light wood turned as near as one will have it: the nave of the wheel of a little ſtronger wood, the bands of the wheel only a line thick, and an inch or thereabout broad; thoſe bands are nailed to their joints, and even glued that they may hold faſter; that wheel thus diſpoſed, you'll apply on each of the joints or bands, a ſky-rocket of the ſame length with the joint, which you'll tie very tight with packthread in three places, *i. e.* in the middle, and at both ends; proceeding thus round the wheel, taking care that one end of the ſtopple which comes out of one rocket, may enter the maſſive of the next, for the communication of the fire to one another without interruption: all this being thus well prepared, the places where the rockets are joined, are covered with paper, putting two or three more papers over it, to hinder the fire from forcing through that way: and at the joints which remain between the two laſt rockets, care muſt be taken to ſtop well that which is to play laſt, with wet paper, and well rammed at the extremity which touches the end of the firſt rocket, to which the fire is ſet at the ſtopple which comes out of it.

To uſe this *girandola*, a foot muſt be made to it, four


REFINER'S SHOP
Crucible

four feet leng, which is eaſily introduced through the nave, to make it turn eaſier; and at the extremity of the nave a pin is adapted, to hinder the wheel from falling while it turns round. Thoſe *girandoles* are nailed at the corner of the theatre or ſcaffold.

Beſides thoſe fire-works, for diverſion, there are others uſed in the defence of places beſieged, to throw on the beſiegers, when they come to the breach, or attack ſome other works.

For a FIRE-BALL, you muſt have a port-fire, a foot and a half, or two feet long, according to the bigneſs the *fire-ball* is to be, on an inch, or an inch and a half of diameter, which muſt be charged with a compoſition made of two pounds of ſalt-petre, a pound of ſulphur, and half a pound of gunpowder, all well pounded ſeparately, and paſſed through a fine ſierce, mixing them all together afterwards.

In caſe the fire ſhould be too ſlow, you'll add to it a little gunpowder pulverized; and ſalt-petre, if it burns too quick, to make it laſt longer; in the middle of the ball ſhould be a little ſack filled with this ſame compoſition; the port-fires ſhall be run thro' that ſack; and over it, the ball ſhall be covered with tow, and chips of wood, dipt in a mixture made of linſeed oil, and oil of turpentine, ſeven pounds of each, and eight pounds of pitch or tar, gently heated, and well incorporated together; the tow and chips muſt be left to be half dry before they are uſed; dipping mean while a piece of very coarſe cloth, in the ſame mixture, to envelope the ball, throwing afterwards on the cloth tow and chips, ſalt-petre and ſulphur coarſely pounded, that the fire may be clearer; obſerving to put by intervals iron ware round the matter which is put in the ball, to make it hold, without being too tight, otherwiſe the fire would be too ſlow; for when the matter is a little looſe, the flame is greater: if you want to quicken the fire you muſt take three pounds of gunpowder pulverized, and a pound of charcoal pulverized likewiſe, and having mixed them well together, ſpread it on a table, and roll the ball, covered with the chips and tow upon it, covering it afterwards with the cloth.

For a FIRE-ROCK, you'll put three pounds of ſulphur in powder, in a glazed earthen pot, place the pot over a little charcoal fire without flame; the ſulphur melted, you'll add to it a pound of mutton ſuet, a pound of gunpowder pulverized, and paſſed through a ſierce, and a pound of ſalt-petre in powder: the whole being well mixed, throw it into a baſon, where it muſt be left to grow cold; or elſe, while it is hot, cover your granadoes, circles, launces, and other artifices with it.

Powder, which will be ſometimes under water, and ſometimes above it. Take gunpowder, three parts of colophone, a fourth of common oil, and a ſixth of ſulphur; mix them all together, and being dry, try if it burns more or leſs than it ought; if it does not burn enough add ſulphur and colophone to it; wrap that mixture in a piece of cloth, then put ſtraw round it, which muſt be tied with packthread, and dip it afterwards in pitch; cover it over again with other ſtraw, which muſt be dipped as the firſt, to keep it from the water; this done, you'll make a little hole in it to ſet it on fire: the mixture would be better, if ſome petroleum was added to it.

To mak *torches*, which are never extinguiſhed either by the wind or rain.—Take old ropes pretty big, and boil them in ſalt-petre water; and when very dry, cover them with ſulphur pulverized, and coarſe gunpowder, mixed with ſome brandy: take afterwards three parts of wax, three parts of pitch, one part of ſulphur, half a part of camphire, and half a part of turpentine, and with all theſe matters mixed together, cover your ropes, putting four of them together; and as a torch in the middle, add beſides, between thoſe four ropes, quick-lime, with three parts of ſulphur mixed together.—Theſe *torches* will light in all weathers.

REFINING.

REFINING is the art of refining metals and ſalts.

All ſorts of metals admit of *refining*, viz. *gold*, *ſilver*, *iron*, *tin*, and *lead*.

GOLD, can be refined in three different manners, *viz.* either with antimony, with ſublimate, or with aqua fortis.

The laſt of theſe three manners, viz. *depart*, and which is the moſt uſual, and moſt dangerous, is alſo called *departing*, or *parting*; the proceſs thereof is as follows.

They take at the rate of one pound of impure gold, and two or three of ſilver; theſe they fuſe together in a crucible, and when fuſed caſt them into cold water, where they become divided into grains of the bigneſs of peas. Theſe grains taken out and dried by the fire, are put in a departing veſſel, which is a ſtone matraſs, and to the matraſs is added four pounds of aqua fortis. Then taking the veſſel, they ſet it on the coals, and in about an hour's ſpace the refining is done. For upon opening the veſſel they find nothing therein but the aqua fortis, and the gold reduced into a calx, or ſand; the ſilver being all diſſolved and imbibed by the water.

To

To raiſe the *gold* to its due fineneſs, they uſually give it the aqua fortis again and again; uſing for the firſt time half a pound, and for the ſecond a quarter of a pound of the water to eight ounces of metal. If the third water be found good and clear, the operation is ended: and the calx of the gold being waſhed in repeated water, is melted down in a crucible, firſt by a gentle, and afterwards a vehement fire, to be caſt into ingots or wedges.

It muſt be added, that the ſilver with the impurities of the gold, are ſo thoroughly incorporated with the water, that to the eye there does not appear any thing beſides the pure liquid, yet this ſilver is not loſt. To recover it again out of the menſtruum, they divide their ſtock of aqua fortis into ſeveral ſtone veſſels, which they fill up with ſpring water, obſerving to put ſeven or eight times as much of this as that. This done, in each veſſel they put a quantity of copper, and leaving the whole for twenty-four hours, at the end thereof they find the particles of the aqua fortis have quitted the ſilver, and are with the copper, leaving the former in form of a calx, or incorporated aſhes at bottom. This calx being dried, is melted into an ingot, with a little ſaltpetre.

To huſband the aqua fortis, and make it ſerve again for a ſecond operation, they diſtil it in an earthen or glaſs alembick; and when the diſtillation is about a third over change the recipient. The water of the firſt recipient ſerves for the firſt operation of *departing*, and the reſt for the ſubſequent ones.

If the aqua fortis, having quitted the ſilver, and being united with the copper, be then filtrated, it is called *aqua ſecunda*, in which, if you ſteep an iron plate ſome hours, you will have another *departure*, for the menſtruum will let go the copper, and prey on the iron, leaving the copper in powder on the iron plate. And filtrating this diſſolution, you may get the iron out of it, by laying in it a piece of lapis calaminaris; for the iron in that caſe will depart to the bottom, and the lapis be diſſolved: and if you again filtrate this water, and pour on it the liquor of fixed nitre, you will have another *depart*, the lapis precipitating to the bottom. And laſtly, filtrating this water as before, and evaporating part of it, you'll have cryſtals of ſaltpetre.

To *refine gold with antimony*, you muſt take an ordinary crucible, of a ſize anſwerable to the quantity of gold to be refined; obſerving that the gold and antimony together do not above half fill it: put that crucible in a wind furnace, with the gold alone in it; and when the gold is melted throw into it the antimony in powder. The proportion of the mineral to the metals, is about a pound to eight ounces, if the gold be between 22 and 16 carrats fine: if it be beneath 16 carrats, they uſe about five quarters of a pound to eight ounces: the coarſer the gold is, the more antimony is required.

As ſoon as the antimony is in the crucible, it is covered up; and after charging the furnace with charcoal, they put on its head a cover, which ſtand till ſuch time as the crucible be left quite bare; then the head being taken off, and the crucible left to cool in the furnace itſelf, till ſuch time as it may be taken out by the hand, they break it to get out the bottom, or culot, which is a maſs of fine *gold* remaining at the bottom, with the focus of the antimony, the ſilver and copper alloy, and ſometimes little particles of gold itſelf over it.

Though the gold thus prepared be very pure, the antimony gives it ſuch a harſh brittle quality, that it ceaſes to be ductile; and muſt be ſoftened by fuſion, with ſaltpetre and borax, to bring it to itſelf.

For this operation they prepare what they call a *dry coppel*, that is, a coppel made of crucible earth, which does not imbibe like the coppel made of aſhes.

The coppel being ſufficiently heated in the refining furnace, they put the gold in it and cover it up with charcoal.

As ſoon as the *gold* is diſſolved, which is very ſoon by reaſon of the remains of the antimony, they blow it with the bellows to drive the mineral entirely away, which now goes off in ſmoak; adding to it, as ſoon as the fumes ceaſe, a little ſaltpetre and borax in powder: which collect the impurities remaining upon diſſolution, and fix the *gold* in the coppel in form of a plate.

The *gold* being taken out of the coppel, and melted afreſh in the crucible, with an addition of two ounces of ſalt-petre, and as much borax in powder, to each eight ounces of *gold*; as ſoon as it ceaſes to fume, they caſt it into an ingot; which, upon trial, is found 23 carrats, 26 thirty-ſeconds fine.

As to the particles of *gold* which may have been left behind with the alloy in the fæces of the antimony, they get them out by a dry coppel, with the ſame meltings and ingredients as are uſed in ſoftening the former. And when they are aſſured by the eſſay, of the ſhare of *gold* the matter contains, they refine it to ſeparate the copper; and afterwards make the depart.

As to the *gold* which may be left ſticking to the dry coppels, they get it out by breaking and pulveriving the crucibles, and by repeated lotions of the powder thereof in ſeveral waters; which is called waſhing.

To *refine gold by means of ſublimate*.—The proceſs is begun like that with antimony, *i. e.* in the ſame furnace, with the ſame coal, the ſame fire, and the ſame crucibles.

The *gold* being melted in the crucible, they caſt in the ſublimate, not pulverized, but only broke in pieces. As to the proportion, to eight ounces of *gold* to be refined, they put an ounce, or an ounce and a half, or even two ounces, if the *gold* be of 22 carrats;

carrats; three ounces if 20 carrats; and 406 ounces, if it only be from 18 to 20 carrats. In which laſt caſe they part the ſublimate into two; putting half at a time, with the *gold*, into a new crucible; which, when the operation is over, leaves the *gold* from 18 to 23 carrats, according to its fineneſs before. After this, they raiſe it further by the fire as follows:

The broken ſublimate being put into the crucible with the melted gold, the crucible is immediately covered up, to ſmother the mineral: which done, the furnace is filled with charcoal, and the head put on. A quarter of an hour afterwards they take off the head, lay the crucible bare, and give the *gold* air, *i. e.* blow off all the aſhes, and other impurities that may be floating on the liquid gold, with a pair of bellows, the nozzle whereof is crooked.

This they repeat again and again, till the impurities of the *gold* being carried off, by virtue of the ſublimate, it be found of a bright glittering colour; after which it is taken out of the crucible, and the *gold* caſt into an ingot.

Gold may alſo be refined with lead and aſhes, as obſerved in Chymiſtry; but this is a method ſeldom uſed, excepting in *eſſays*.

For the method of *aſſaying gold*.—The aſſayer having weighed the *gold* he intends to make the trial in, very exactly, with ſcales that will turn with the hundredth part of a grain, and noted down the weight, and twice as much fine ſilver thereto; though this ſhould be in proportion to the fineneſs the *gold* ſeems to be of, the baſeſt *gold* requiring the leaſt ſilver. The gold and ſilver thus weighed and mixed, are wrapped up in a piece of paper, to prevent their loſing any thing of their weight, which would diſturb the accuracy of the eſſay.

While the *aſſayer* is weighing his matters, a reverberatory fire is lighted in a furnace, furniſhed with a muffler and a coppel or teſt ſet therein to heat. This done, a little bullet of lead is put in the coppel, of a weight proportionable to the quantity and quality of the *gold* to be aſſayed. When the lead is well melted, and appears very clean and bright, they put in the gold and ſilver, and let it fuſe and ſeethe till it appears of an opal colour, and hath fix'd itſelf in a little lump to the bottom of the coppel.

This done, the coppel is left to cool in the furnace itſelf; after which the lump is ſeparated very exactly from the place where it ſtuck to the veſſel, and ſtretched and hammered on the anvil, heating it again and again on the coals, to promote the ſtretching.

When ſufficiently hammered, they roll it up in form of a cornet or coffin, and thus put it in a glaſs matraſs, capable of containing four ſpoonfuls of water; and having added to it a quantity of aqua fortis well corrected, that is, mixed with near one third of the quantity of river water; they boil it over a wood fire, till ſuch time as the aqua fortis yields no more red fumes.

This firſt water being poured off and the cornet left alone at the bottom of the matraſs, they fill the matraſs again, but with pure aqua fortis; which, after boiling, is poured off in its turn at ſuch times as the fumes are become white.—This done, they fill up the matraſs with river water, to waſh the cornet.

When waſhed they put it dry in a crucible, with a cover over it, and heat it till it become of a cherry-colour.

This done, the *aſſay* is finiſhed; and there remains nothing but to weigh it againſt the ſame weight of fine gold, as was uſed at firſt before the aſſay; for by comparing the firſt weight of the gold ere it was put in the fire, and the aqua fortis, with what it returned after it had thus undergone the teſt; they judge from the greater or leſs loſs it has ſuſtained, of the quantity of alloy mixed with it.

Now for *refining ſilver*; which is done two ways; the one with lead, the other with ſalt-petre. The beſt and cheapeſt is that with lead.

To *refine ſilver with lead*; a coppel is filled with a mixture of brick aſhes, and aſhes of a bullock's or other bones. It is ſet on the fire and heated red hot; in which ſtate the lead is put in, and when this is melted, the *ſilver*, in the proportion of a pound of lead to four or five ounces of ſilver, and even ſomewhat more lead, if the *ſilver* be very coarſe. As theſe two metals melt together, the copper, before mixed with the *ſilver*, diſſipates in ſmoak, or goes away with the ſcum and litharge, and ſo does the lead itſelf; leaving the ſilver alone in the coppel, in its proper degree of fineneſs.

In this method of *refining*, wherein 6 or 7000 pounds may be refined at once; the metal is drawn out of the coppel two ways; the one by plunging in it, while ſtill liquid, a thick bar of iron, round which the *ſilver* ſticks in form of a ſhell, or cruſt; repeating this again and again: the other is by letting the coppel ſtand till it be cold; in the bottom whereof the ſilver fixes in form of cake.

The *refining ſilver with ſalt-petre*, is performed in a wind-furnace.—The *ſilver* to be refined having been reduced into grains of the ſize of little peas, by pouring it, when melted, into a tub of common water; it it heated over again in a boiler. After this they put it in a crucible, and along with it, to every eight ounces of metal, two of ſalt-petre.

The crucible is now covered up with an earthen lid, in form of a dome, exactly luted; which lid however is to have a little aperture in the middle.

The crucible being put in the furnace, and covered with charcoal, which is only to be lighted by degrees; at length they give it the full force of the fire to put the metal into a perfect fuſion. This

they

they repeat three times ſucceſſively, at an interval of a quarter of an hour.

After a third fire they uncover the furnace, and let the crucible cool; and at length break it, to get out the ſilver, which is found in a button or culot; the bottom whereof is very fine ſilver; and the top mixed with the fæces of the ſalt-petre, and the alloy of the ſilver, and even ſome particles of the fine ſilver.

The culot being ſeperated from the impurities, is melted in a new crucible, and into the diſſolution is thrown charcoal-duſt, and the whole briſkly worked together. Then the crucible being covered up again, and the furnace charged with coal, a ſecond fire is given it.

This done, the aſhes, and other impurities are blown from the top of the metal, till it appears as clear as a looking-glaſs; and then an ounce of borax broke in pieces is thrown in.

Laſtly, the crucible being covered up again, they gave it the laſt fire; after which it is caſt into ingots; which are found eleven penny-weights, and ſixteen grains fine.

To recover the ſilver that may be left in the fæces, or ſcoria, they pound them, and give them repeated lotions in freſh waters.

But both the one and the other manners are tedious and troubleſome, when performed on large quantities. This occaſioned M. *Homberg* to endeavour to ſhorten the operation; which he effected with good ſucceſs. His method is, to calcine his ſilver with half its weight of common ſulphur; and after melting the whole together, to caſt a quantity of ſteel-filings upon it at ſeveral times: upon this the ſulphur quits the ſilver, and joins itſelf to the iron, and both are converted into ſcoria, which ſwim on the ſilver; and the metal itſelf is found pure at the bottom of the crucible.

The *aſſay of ſilver* is much after the ſame manner of that of gold; only leſs difficult and ſhorter. The ſilver is weighed as before; and the ſame furnace, and muffler, the ſame fire, the ſame coppel uſed. Add, that lead is alſo put in the coppel, proportioned to the quantity and quality of the ſilver to be aſſayed.

The lead being well melted and clear, the ſilver is put in; and after it is brought to an opal colour, and fixed in a lump at the bottom of the coppel, which happens in about half an hour; they let it cool, and cleanſe it; and laſtly, weigh it again as in gold; and from its diminution eſtimate the quantity of alloy.

The *refining of* Copper, is only performed by giving the mineral matter ſeveral lotions before the melting it, and then giving it ſeveral repeated fuſions.

The *refining of* Tin, is performed much after the ſame manner of that of copper, though we may diſtinguiſh two kinds of fineneſs of this metal: the one ariſing from its fuſion, that *tin* taken firſt out of the furnace wherein it is melted, being always purer than that towards the bottom.

The other kind of fineneſs is that given the *tin*, by adding ſome other metal or mineral to it, to render it more ſonorous as well as brighter; ſuch is *tin* of antimony, Pewter, *&c.*

For the *method of aſſaying tin*.—To find whether *tin* be ſoft and ductile, or harſh and brittle, there are two kind of aſſays:—The firſt, is by putting the *tin* in a mould of caſt braſs, and there melting it. If the metal be harſh, it will be taken out heavier than before; otherwiſe it will be lighter. The ſecond, is by caſting the melted *tin* into a little mould, made of the thunder-ſtone. This mould has a little canal of moderate length, which conducts the matter into a cavity, capable of containing half a billiard ball: if the *tin* be harſh, it appears whitiſh towards the entry of the mould; otherwiſe it is tinged ſuperficially with a very faint bluiſh brown.

Refining of Iron, begins likewiſe by melting it. The greater degree of fuſion the mineral has, the more the metal is purified: But this firſt fuſion is not ſufficient. To render the iron malleable, and fit to endure the file, it muſt be melted a ſecond time; then forged or beaten a long time with huge heavy hammers, wrought by water; then heated in the fire, and at laſt reduced on the anvil into bars of ſeveral thickneſſes.

The more the iron is heated in the fire, and the more it is beaten, whether hot or cold, the finer it becomes.

Steel is only iron refined to a great degree by heating it with ſome other ingredients, which cloſe up the pores and ſoften the grain thereof.

Refining of Lead, is performed like that of moſt other imperfect metals, by frequent meltings, ſtill ſcumming it before it be cold; and caſting in tallow and other kind of fat.

There is alſo an *Aſſay made of lead*; for the aſſay of gold and ſilver, being performed by means of lead; 'tis of the utmoſt importance, the lead be free of any mixture of either of the two metals: Otherwiſe the *aſſay* will be falſe, by reaſon the gold and ſilver mixed with the lead, will not evaporate like other kinds of alloy, but unite with the metal under *aſſay*.

To prevent this diſorder, and aſſure the operation, there is no way but to aſſay the lead itſelf.

This *aſſay* is performed in the ſame furnace, and with the ſame coppels, as thoſe of gold and ſilver: But the proceſs is incomparably more ſimple. All here required, when the coppel is heated, being to put in the piece of lead to be aſſayed. If this lead evaporates entirely, it is fit for the purpoſe. On the contrary, if there remain a little grain of ſilver, *&c.* at the bottom, it muſt be ſet aſide.

SCULP-

RHETORICK.

RHETORICK, is the art of cloathing our thoughts with words, ſo as they may be either inſtructive, perſuaſive, or entertaining, whether we ſpeak, or write; and it is commonly divided into four parts, viz. *invention*, *diſpoſition*, *elocution* and *pronunciation*.

INVENTION is to find out arguments, which the orator is to uſe for the proving his point, or moving his hearers paſſions.

ARGUMENTS are alſo divided, with reſpect to the place they are drawn from into *intrinſick* or artificial; and *extrinſick* or inartificial, or remote.

Artificial or *intrinſick* ARGUMENTS, are the proper invention of him who ſpeaks; or thoſe, which are taken from the ſubject treated of: of which there are ſeveral kinds, viz. *genus* and *ſpecies*, *form*, *cauſe*, and *effect*, &c.

To theſe ſome add two other places of *argument*, viz. the *manners*, and the *paſſions*.

Inartificial or *extrinſick* ARGUMENTS, are thoſe, which are borrowed from abroad, and only applied by the orator to the point in hand; ſuch are laws, common report, books, oaths, torture, and witneſſes.

A late author divides the places or general heads of arguments, with regard to their end, into 1. Thoſe intended to perſuade or diſſuade, which are chiefly drawn from the conſideration of profit, honour, and equity. 2. Thoſe intended to praiſe or diſpraiſe. And 3. Thoſe intended to accuſe and defend.

The DISPOSITION is defined, the art of diſtributing the things or arguments invented, or found out into a proper order; or a due placing, or ranging the ſeveral parts of a ſpeech or diſcourſe; which parts are uſually reckoned four, viz. the *exordium* or beginning; the *narration*, the *confirmation*, and the *peroration* or *concluſion*, though ſome make them ſix, viz. the *exordium*, *diviſion*, *narration*, *confirmation*, *confutation*, and *peroration*, as indicated in that popular verſe,

Exorſus, narro, ſeco, firmo, refuto, peroro.

But the *Diviſion* is more naturally referred to the *exordium*; and the *confutation* to the *confirmation*.

The EXORDIUM is the preamble or beginning of a diſcourſe or ſpeech; ſerving to prepare the audience, and introduce the matter in hand.

Exordiums are of two kinds; either juſt and formal; or vehement and abrupt. In the firſt, the audience is prepared and conducted by due and eaſy ſteps; in the ſecond, the orator, as if ſeiz'd with ſome ſudden paſſion, breaks out upon his audience at once. Such is that *exordium* of *Iſaiah*, *Hear, O heavens, and give ear, O earth:* Or that of *Cicero* againſt *Catiline*, *Quouſque tandem abutere patientia noſtra Catilina? How long*, Catilina, *wilt thou abuſe our patience?*

Abrupt *exordiums* are the moſt ſuitable on occaſions of extraordinary joy, indignation, or the like.

The requiſites in an *exordium* are, 1. *propriety*, whereby the *exordium* becomes of a piece with the whole diſcourſe, and matches it as a part does a whole; ſo that it could not be accommodated to any other, or perhaps a contrary occaſion.

2. *Care*, accuracy and magnificence, as being the part moſt minded, and moſt expoſed to ſhew.

3. *Modeſty*, or an ingenious baſhfulneſs, which recommends the orator exceedingly to the favour of his audience. *Tully* owns of himſelf, that at the beginning of his orations he trembled every limb, and his whole mind was in a flutter.

And 4. *Brevity*, not exemplified or ſwelled, with a deal of circumſtances, or a long circuit of words.

The DIVISION ſeldom finds place in any other diſcourſes, but in *ſermons* and *panegyricks*, and is invented only to eaſe the memory of the orator. The diviſion ſhould be always, as much as poſſible, contained in the text: for example, if I was to preach a ſermon on the grace of *Jeſus Chriſt*, and take for text of my diſcourſe this paſſage of St. *Paul*, *It is by the grace of God that I am what I am, and the grace of God has not been void in me*; I would divide my diſcourſe into two parts, proving in the firſt the power of grace, alluding to the firſt part of my text, *It is by the grace of God that I am what I am*; and in the ſecond, the neceſſity of our co-operating with grace, and *the grace of God has not been void in me.*

The NARRATION is a recital or rehearſal of a fact as it happened, or as it is ſuppoſed to have happened.

This is of two kinds, either *ſimple* and *hiſtorical*, as where the auditor or reader is ſuppoſed to hear or read of a tranſaction at ſecond-hand—or *artificial* and *fabulous*, as where their imaginations are raiſed, and the action, as it were re-acted before them.

Cicero requires four virtues in a *narration*, viz. *perſpicuity*, *probability*, *brevity* and *ſweetneſs*.

The *narration* is rendered *perſpicuous*, by obſerving the order of time, by uſing none but proper and known terms, and by reciting the action uninterruptedly.

It is rendered *probable*, by the credibility of the narrator, by the ſimplicity and openneſs of the *narration*, by avoiding every thing far remote from

the common ſenſe and opinion of mankind, and by a preciſe detail of circumſtances.

It is rendered brief, by taking it up no higher than is juſt neceſſary, nor fetching it back, as that impertinent author in *Horace*, *qui genuino bellum Trojanum orditur ab ovo*; and by avoiding trivial circumſtances.

Laſtly, It is rendered ſweet, by uſing ſmooth, numerous and well-ſounding words; by arranging them, ſo as to avoid any hiatus or claſhing; by the greatneſs, novelty, and unexpectedneſs of the things related; and by enriching it with tropes and figures, as frequent admirations, exclamations, interrogations, expectations, ſuſpences, ſurpriſing events, by grief, joy, fear, &c.

CONFIRMATION is that part of an oration, wherein the orator undertakes to prove, by laws, reaſon, authorities, and other arguments, the truth of the propoſitions advanced in his narration.

Confirmation is either *direct* or *indirect*; to the firſt conforms what the orator has to urge for ſtrengthening his own cauſe; the ſecond properly called *confutation*, refels the oppoſite arguing of the adverſaries, the two parts together being ſometimes placed under the head or title of *contention*.

The *confirmation* is, as it were, the life and ſoul of the oration; in this the main ſtreſs of the argumentation lies, whence *Ariſtotle* properly enough calls it *fides*.

The *peroration* is the epilogue or laſt part of an oration; wherein, what the orator inſiſted on through his whole diſcourſe is urged afreſh, with greater vehemency and paſſion.

The *peroration* conſiſts of two parts, 1. Recapitulations, wherein the ſubſtance of what was diffuſed throughout the whole ſpeech, is collected briefly and curſorily, and ſummed up with new force and weight.

2. The moving the paſſions, which is ſo peculiar to the *peroration*, that the maſters of the art call this part *ſedes affectuum*.

The paſſions to be rais'd in the *perorations* are various, according to the various kinds of orations: in a panegyrick, love, admiration, emulation, joy, &c. in an invective, hatred, contempt, &c. in a deliberation, hope, confidence, or fear.

The qualities required in the *peroration* are, that it be vehement and paſſionate, and that it be ſhort; becauſe, as *Cicero* obſerves, tears ſoon dry up.

The *peroration* was *Cicero*'s maſter-piece. Here that great orator not only ſet his judges and auditors on fire, but even ſeemed to burn himſelf; eſpecially when he was to raiſe pity and commiſeration towards the accuſed; where, as he himſelf tells us, he frequently filled the forum with weeping and lamentation.

The ELOCUTION is defined by *Tully*, the chaſing and adapting of words and ſentences to the things or ſentiments to be expreſſed.—To the *elocution* then properly belongs the choice of words. To expreſs a mean or low thing, in great and magnificent words, is, ſays *Longinus*, as if one would put a large maſk on the face of a young child; unleſs it be in poetry.

The beauty of *elocution* conſiſts chiefly in the uſe of figures, and figurative dictions or expreſſions, in the periods and the ſtile.

A PERIOD, according to *Ariſtotle*, is a diſcourſe which has a beginning, a middle, and an end, all viſible at one view.

The *periods* allowed in oratory are three; a *period* of two members, called by the Greeks *dicolos*, and the Latins *bimembris*: a *period* of three members, *tricolos*, *trimembris*: and a *period* of four members, *quadrimembris*, *tetracolos*.

A ſtrict *oratorial period*, does not allow of either more or fewer than theſe; it is poſſible, indeed, to introduce a *period* of one member, called by *Ariſtotle*, *monocolos*, or *ſimple period*, but it will be reputed a flaw, and is a thing never practiſed by the maſters.

The *period* may be likewiſe prolonged to five or ſix members, but then it changes its name, and inſtead of a *period*, commences a periodical diſcourſe.

A *period* of two members *Cicero* ſupplies us with: *Ergo & mihi meæ priſtinæ vitæ conſuetudinem, C. Cæſar, interclusam aperuiſti; & his omnibus ad bene de republica ſperandum quaſi ſignum aliquod ſuſtuliſti.*

A *period* of three members the ſame *Cicero* gives us in the exordium of his *Manilian oration*: *Nam cum antea per ætatem hujus autoritatem loci contingere non auderem; ſtatueremque nihil huc niſi perfectum ingenio, elaboratum induſtria afferri oportere; omne meum tempus amicorum temporibus tranſmittendum putavi.*

A *period* of four members he gives us in that admirable deſcription of the puniſhment of *parricides*. *Ita vivum ut ducere animum de Cælo non queant: ita moriantur ut eorum oſſa terra non tangat: ita jactantur fluctibus, ut nunquam abluantur: ita poſtremo ejiciuntur, ut ne ad ſanos quidem mortui conquieſcant.*

In oratory, the members of *periods* are to be equal, or nearly equal; that the pauſes, or reſts of the voice, at the cloſe of each member, may be nearly equal: but in writings no ways intended for rehearſal, this is diſregarded.

Periods are ſaid to be either *rotundi*, round, or *quadrati*, ſquare, according to their different œconomy and cadences, or numbers, which numbers

are a ſort of ſimple unaffected harmony, leſs glaring than that of verſe, yet ſuch as is perceived, and affects the mind with pleaſure.

The *numbers* are that by which the ſtile is ſaid to be eaſy, free, round, flowing, &c.

The *ſquare period* is that conſiſting of three or four equal numbers, formerly diſtinguiſhed from each other.

The *round period* is that whoſe members or parts are ſo connected, and fitted into each other, as that the junctures or commiſſures are ſcarce ſeen; but the whole ſlides equally round, without any notable ſtops or inequalities.

Now for the *ſtile*, which is another part of the *enunciation*.

Stile, in matter of language, is a peculiar manner of delivering a man's thought in writing agreeably to the rules of ſyntax; or, as Father *Buffier* more accurately defines it, the manner wherein the words contracted according to the laws of ſyntax, are arranged among themſelves, ſuitably to the genius of the language.

From the definition, it appears, that *ſtile* ſuppoſes, or includes the ſyntax; and that ſyntax does not extend ſo far as *ſtile*: for the ſyntax may be very juſt where the *ſtile* is wretched.

Rhetoricians reduce the kinds of *ſtiles* to three; the *ſublime*, the *low*, and the *intermediate*, or *equable ſtile*.

Sublime ſtile is that conſiſting in magnificent words and ſentences; which by its noble boldneſs raviſhes the hearers, and extorts admiration even from the unwilling.

Low or *ſimple ſtile* is that ordinarily uſed in ſmaller and humbler works; as epiſtles, dialogues, and common diſcourſe. The chief virtues hereof are perſpicuity, ſmoothneſs, eaſineſs, and cleanneſs; it muſt be very ſparing in the uſe of tropes and figures, eſpecially the more violent ones, as the proſopopæia, apoſtrophe, &c.

Intermediate or *equable ſtile* partakes of the magnificence of the *ſublime* and the ſimplicity of the *low*. It neither riſes to the majeſty of the one in words and ſentences; nor yet is ſmartly pointed like the other; but, as *Tully* excellently expreſſes it, *eſt ſtilus quidam interjectus, intermedius, & quaſi temperatus; nec acumine inferioris, nec fulmine utens ſuperioris, vicinus amborum, in neutro excellens, utriuſque particeps.*

The ſame author calls it the *florid* and *poliſhed ſtile*; it being in this that all the graces and beauties of language are principally to be uſed.

For the choice of *ſtile*, in the general, the matter is to determine it. Such *ſtile*, ſays *Cicero*, is to be choſen, as expreſſes great things magnificently, middle things moderately, and low things ſubtilly: but more particularly, as there are three branches of the duty of an orator, to *teach*, to *delight*, and to *move*; the ſimple *ſtile* is uſed to teach; the middle to *delight*; and the ſublime to *move*.

The beauty of the periods and ſtile conſiſts chiefly in the *figures* which enter the compoſition.

FIGURE, in *rhetorick*, is a phraſe or turn of ſpeech or diſcourſe, finer and nobler than what is uſed in common or ordinary ſpeaking; or the enrichments of diſcourſe, which we only uſe when raiſed, and moved with the conſideration of ſomething extraordinary.

There are two kinds of *figures*; the one of *ſentences*, and contained in the ſenſe itſelf, without any immediate dependance on any particular words; the others are only in the *words* themſelves.

Of the *figures* of *ſentences*, ſome are deſigned to *move*, others to *teach*, and others only to *delight*.

Of the *firſt* kind the moſt conſiderable are, *exclamation*, *imprecation*, *obſecration*, *interrogation*, *doubting*, *præterition*, *expolition*, and *epiphonema*.

Thoſe of the *ſecond* are the *antitheſis*, *correction*, *communication*, and *ſuſpenſion*.

Thoſe of the *third*, the *apoſtrophe*, *hypothypoſis*, *proſopopæia*, *ethopæia*, and *proſopographia*.

The *exclamation* is a *figure*, wherein, by raiſing the voice, and uſing an interjection, either expreſſly or underſtood, we teſtify an uncommon warmth and paſſion of mind; and expreſs the magnitude of the thing, or the importance of the occaſion.

Such is, *O heavens! O earth! O times! O manners!*

The *imprecation* is a kind of curſe, expreſs'd in diſcourſes, by *may* or *let*; for inſtance, *May the enemies of God be confounded! Let the wicked be puniſhed! &c.*

The *interrogation* is a figure wherein the paſſion of the ſpeaker introduces a thing by way of queſtion, to make its truth more conſpicuous.

Doubting is a figure wherein the orator appears ſometimes fluctuating, and undetermined what to do, or ſay. What ſhall I do? ſhall I apply to thoſe I once neglected! or implore thoſe who now forſake me!

The *obſecration* is a figure whereby the orator implores the aſſiſtance of God or man.

This figure *Cicero* makes admirable uſe of, for King *Dejotarus* to *Cæſar*.—*Per dexteram te iſtam oro, quam Regi Dejotaro hoſpes, hoſpiti porrexiſti: iſtam inquam dexteram non tam in bellis, & prœliis, quam in promiſſis, & fide firmiorem.*

The *preterition* is a figure, whereby in pretending to paſs over a thing untouched, we make a ſummary mention thereof, for inſtance—*I will not ſay he is valiant, he is learned, he is juſt, &c.*—The moſt artful praiſes are thoſe given by way of

preterition.—This figure is also called *paralepsis* and *aposcopesis.*

Expolition is a figure whereby we explain the same thing in different phrases and expressions, in order to shew it more fully. The scriptures are full of such figures.

Epiphonema is a sententious sort of exclamation, frequently added after a narrative, or rehearsal of any thing remarkable; containing, usually, a lively close reflection on the subject there spoken of.

Such is that of St. *Paul*, when, after discoursing of the rejection of the *Jews*, and the vocation of the *Gentiles*, he cries out,

Oh the depth of the wisdom and knowledge of God!

The *antithesis* is a setting two things by way of exposition to each other, that the different qualities of each may appear the more strongly.

Such is that of *Cicero* in the second *Catilinarian*: *On the one side stands modesty, on the other impudence; on the one fidelity, on the other deceit: here piety, there sacrilege; here continency, there lust, &c.*

Correction is a figure, whereby a person in a passion, fearing he has not expressed a thing fully or strongly enough, calls it back again, as it were, by a stronger phrase, and corrects the error. This is also called *epanorthosis.*

Such is that of *Cicero for Cœlius*: *O stultitia! stultitiam ne dicam, an impudentiam singularem!* Oh folly! folly did I call it, or rather intolerable impudence?

Suspension is a keeping the hearer in suspence, and attentive, in expectation of what the speaker will conclude in, as, *O God! darkness is not more opposite to light, tempests to calm, pain to pleasure, or death to life, than sin to thee.*

The *apostrophe* is a figure, whereby the orator, in an extraordinary commotion, turns his discourse from the audience, and directs it to some other person or thing.

Thus *Cicero* in his oration for *Milo*, addresses himself to the great patriots, who had shed their blood for the publick, and calls them to the defence of his client.

The *apostrophe* is also frequently addressed to inanimates, as tombs, monuments, defuncts, *&c.*

That *apostrophe* of *Demosthenes*, wherein he addresses himself to the *Greeks* slain at the battle of *Marathon*, is famous. Cardinal *du Perron* says, it has procured the orator as much glory, as if he had raised them from the dead.

The *hypotyposis* is a figure whereby a thing is so lively described or painted, that it does not seem to be read or heard, but actually seen, or presented before the eyes.

Such is that elegant one of *Cicero*, wherein he paints the barbarity of *Verres*: *Ipse inflammatus scelere, & furore, in forum venit. Ardebant oculi; toto ex ore crudelitas emanabat. Expectabant omnes quo tandem progressurus, aut quidnam acturus esset; cum repente hominem corripi, atque in fori medio nudari ac deligari, & virgas expedire jubet; clamabat ille miser se civem esse Romanum*, &c.

The *ethopœia* or *ethopœa*, called also *ethology*, is a draught or description, expressing the manners, passions, genius, tempers, aims, *&c.* of another person.

Such is that beautiful passage in *Sallust*, in his *Bellum Catilinarium*, wherein he gives a picture of *Catiline*: *Fuit magna vi & animo & corporis sed ingenio malo pravoque huic*, &c. *He had an uncommon strength both of body and mind; but an ill-turned and wicked disposition. When a mere boy, his great pleasure was in intestine broils, rapine, slaughter, and civil discord. His body was formed to undergo fasting, cold, and watching, beyond all belief. His mind was daring, deceitful and various; and could imitate, or accommodate itself to every body: he was extremely covetous of other people's goods, and profuse of his own withal: his lusts and desires were very high; his stock of eloquence considerable; but his discretion, scarce any.*

The *ethopœia* is divided into *prosopographia*, and *ethopœia* properly so called; the former of which is a picture of the body, countenance, make, dress, gait, *&c.* and the latter of the mind.

The *prosopopœia*, is a figure whereby we make persons that are absent or dead, or even things which are inanimate, as cities, *&c.* to speak.

There are two kinds of *prosopopœia's*; the one direct, the other indirect. For an instance of the latter; *Just gods, protectors of the innocent, permit the order of nature to be interrupted for one moment, and let this carcass resume the use of speech*, &c.

Instances of the former are found every where among the orators and poets: that which follows is a very beautiful one, found by way of epitaph on a tomb-stone: the dead wife addresses her surviving husband thus:

Immatura peri: sed tu feliciter, annos
Vive tuos, conjux optime, vive meos.

'I have been snatched away, before I was arrived yet to the years of my maturity; but thou, much happier, O the best of husbands, may the years I should have lived be added to thine.'

Of *figures of words*, some are tropes, i. e. translations of words from their proper signification, to some more remote and extraordinary one.

The principal of these are, the *metaphor*, *allegory*,

gory, *metonimy*, *ſynechdoche*, *irony* and *ſarcaſm*, *metalepſis*, *antonomaſia* and *ſylepſis*.

Others are *figures of words*, properly ſo called, and not tropes, being ſo inherent in the words, that upon changing of thoſe the figure is deſtroyed; as in *amantes ſunt amentes*, where the figure would be loſt, if inſtead of *amentes* you ſhould put *ſtulti*.

Of theſe the principal are *repetition*, *converſion*, *complexion*, *gradation*, *ſynonymy*, *polyſyndeton* and *polyptoton*, *reticency*, *diſtinction*, *ſimilitude*, *paronomaſy*, and *tranſition*.

Trope is a word or expreſſion, uſed in a different ſenſe from what it properly ſignifies. Or a word changed from its proper and natural ſignification to another with ſome advantage; as when we ſay an *aſs* for a *ſtupid perſon*.

It is called *trope*, τροπος, from the *greek* τρεπω, *verto*, *I turn*, *change*.

This change or inverſion is performed various ways, but chiefly four; whence ariſe four principal tropes, *viz.* the *metaphor*, *metonimie*, *ſynechdoche* and *irony*.

Some alſo refer the ſix kinds of ſcoffing or deriſion to the *tropes*, *viz.* the *ſarcaſm*, *diaſyrm*, *charientiſm*, *aſteiſm*, *mycteriſm*, and *mymeſis*, but without ſufficient reaſon.

Now for the explication of each of the different *figures* of words, beginning with the *metaphor*.

The *metaphor* is a figure of ſpeech, whereby a word is transferred from its proper ſignification to another; or whereby the proper denomination of one thing is applied to another; which other thing is more elegantly explained by this tranſlatitious, or foreign name, than by that which naturally belongs to it. As when we ſay the light of the underſtanding; to burn with zeal; to float between hope and deſpair, *&c.*

Quintilian diſtinguiſhes *metaphors* into four kinds. The *firſt*, when a word is transferred from one animal to another; as when *Livy* ſays, that *Cato* uſed to bark at *Scipio*; or, when our Saviour calls *Herod* fox. The *ſecond*, when the word is transferred from one inanimate to another; as *bridle* for *laws*. The *third* when inanimates are applied to animates; as the flower of youth. And the *laſt*, when animates are applied to inanimates; as the river *diſdained* its bounds.

A *metaphor* ſhould have nothing in it either coarſe or ſhocking, or that may raiſe it above the ſimplicity of nature: nor ſhould it appear a *metaphor* to any but thoſe who view it very cloſely. *Metaphor* ſhould never be carried too far; for in that caſe it degenerates into puerility. In all metaphorical dictions there ſhould be a kind of unity, ſo that the different words uſed may have a kind of ſuitableneſs to each other: different ideas are always abſurd.

The *allegory* is a figure whereby we make uſe of terms, which in their proper ſignification mean ſomething elſe than what they are brought to denote; or it is a figure, whereby we ſay one thing, expecting it ſhall be underſtood of another, to which it alludes.

An *allegory* is properly a ſeries of metaphors.—Such is that beautiful allegory in *Horace*, lib. 1. Od. 14.

O navis, referent in mare te novi
Fluctus, &c.

Where the ſhip is uſually held to ſtand for the *republick*; *waves* for *civil war*; *port* for *peace* and *concord*; *oars* for *ſoldiers*; *mariners* for *magiſtrates*, &c.

The old teſtament is ſuppoſed by many to be a perpetual *allegory*, or typical repreſentation of the myſteries of the new.

The *metonymy* is a rhetorical trope, conſiſting in a tranſmutation, or change of names; or a putting off the effect for the cauſe, or the ſubject for the adjunct; and *vice verſâ*.

There are four kinds of *metonymies* in principal uſe: the *firſt*, when we put the inventor for the thing invented; as *Bacchus* for *wine*; *Ceres* for *bread*. The *ſecond*, when we put the containing for the thing contained; as a glaſs for the wine within it. The *third*, when effect is put for the cauſe; as the captain for his ſoldiers, *Greece* for the *Greeks*, the author for his works. The *fourth*, when the ſign is put for the thing ſignified; as the gown for the prieſthood, *&c.*

Synecdoche is a kind of figure, or rather trope, frequent among orators and poets.

There are three kinds of *ſynecdoches*: by the *firſt*, a part is taken for the whole; as the point for the ſword, the roof for the houſe, the ſails for the ſhip, *&c.*—By the *ſecond*, the whole is uſed for a part.—By the *third*, the matter whereof the thing is made, is uſed for the thing itſelf; as ſteel for ſword, ſilver for money, *&c.* to which may be added another kind, when the ſpecies is uſed for the genus, or the genus for the ſpecies.—As *he bore the ſin of many*, i. e. of all.

The *irony* is a figure in ſpeech, wherein we plainly intend ſomething very different from what our words expreſs: as when we ſeem to praiſe a perſon at a time, when we evidently rally and diſcommend him.—The irony diſcovers itſelf rather in the tone of the ſpeaker, than in the words.

Sarcaſm is a keen, bitter irony, whereby the orator ſcoffs and inſults his adverſary.—Such was that

that of the *Jews* to our Saviour: *He saved others, himself he cannot save.*

Antonomasia is a figure whereby a noun appellative is used instead of a proper name, or *vice versa*. Thus we say, the philosopher, instead of *Aristotle*; the orator, for *Cicero*.

The *syllepsis* is a figure whereby we conceive the sense of words otherwise than the words import; and thus make our construction, not according to the words, but the intention of the author.

It is a figure of considerable use for the well understanding of authors.—*Scioppius* divides it into two kinds, *simple* and *relative*.

Simple syllepsis is when the words of a discourse either disagree in gender or number, or both.

Relative syllepsis is when the relative is referred to an antecedent, which is not expressed; but which we conceive by the sense of the whole period.

As to the *figures of words* properly so called, the first is *repetition*, which is a figure whereby the orator rehearses the same word or phrase over again.

Of this there are two kinds.— In the *first* the words are repeated precisely in the same sense: As, *Oh Jerusalem, Jerusalem, who killeth the prophets,* &c. *my God, my God, why hast thou forsaken me?*

The second kind of repetition called πλοκη, is a *repetition* of the same word, in the same phrase; but in such a manner as that some new idea or character is added to the words in the second, which it had not in the first.

As *Corydon* is always *Corydon: ex illo Corydon, Corydon est tempore nobis*; by which we signify that *Corydon* is no ordinary person; and that nothing can distinguish him but the repetition of his own name: As if we should say, *he is Corydon, that is enough.*— By the same figure our Saviour speaks, when he says, *let your language be yea, yea, and nay, nay.*

Conversion in *rhetorick*, is understood of arguments which are returned, retorted, and shewn on opposite sides, by changing the subject into the attribute, and the attribute into the subject.

Complexion is a figure, including a repetition, and a conversion at the same time; the sentence both beginning and ending with the same word.

Thus *Tully, Quis legem tulit? Rullus, quis comitiis præfuit, Rullus,* &c.

Gradation is when a series of considerations or proofs is brought, rising by degrees, and improving each on the other.

Such is that in *Cicero* to *Catiline, nihil agis, nihil moliris, nihil cogitas; quod ego non audiam, quod etiam non videam, planeque sentiam.* This figure is also called *climax*.

Synonymy is a figure whereby synonyms or synonymous words, that is, various forms of the same signification, are made use of, to amplify the discourse.

Such is that passage of *Cicero, abiit, evasit, effugit, erupit*, he went off, he escaped, he run away, &c.

The *polyptaton* is the figure, wherein the same word is repeated in different cases, genders, or numbers, *i. e.* with different terminations.

Such is that of *Cicero, pro Arch. Sed pleni sunt omnes libri, plenæ sunt sapientum voces, plena exemplorum vetustas.*

Reticency is a figure whereby we make oblique mention of a thing, in pretending to pass it over unmentioned.

Thus: *To say nothing of the nobility of his ancestors: I forbear to speak of his courage, and pass over the severity of his morals.*

The *comparison* is a figure, or rather place in speech, whereby two things are considered, with regard to some third, which is common to them both.

Thus *Cicero Topic. Catoni licuit sequi bellum civile, igitur et Ciceroni licebit. It was allowed Cato to engage in the civil war, therefore it may be allowed Cicero:* where to engage in the civil wars is common to both.

There are three kinds of *comparison*; the first *a majori*, i. e. from the major to the minor, as that of Cicero against *Antony, Quid feceris domi tuæ, cum alienæ tam sis insolens?*

The second *a minori*, i. e. from the minor to the major: Thus *Cicero, Majores nostri sæpe mercatoribus, ac naviculatoribus imperiosius tractatis, bella gesserunt; vos tot civium Romanorum millibus uno nuntio, atque uno tempore necatis, quo tandem animo esse debetis?*

The third *à pari*; as when we contend that what obtains in one thing, ought to obtain in another of the same kind: thus, *it was a law, that he who killed his father should be sewed up in a sack and thrown into a river; therefore, he who killed his mother deserves the same punishment.*

The *paronomaty* is a figure, whereby words nearly alike in sound, but of very different senses, are affectedly or designedly used.

The *transition* is a kind of connexion in discourse, whereby the several parts and members thereof are joined, so as to constitute one regular whole.

Father *de Colona* makes two kind of *transitions*; the one *perfect*, the other *imperfect*.

Perfect transition is that wherein we briefly intimate what is said, and what remains to be said: As, *now that we have spoke of war, there remains something to be said of peace.*

Imperfect transition is that wherein only one of these is expressed.—As, *Let us now consider the consequences of,* &c.

Longinus

Longinus recommends alſo the images in the diſcourſe, which he defines to be, in general, any thoughts proper to produce expreſſions, and which preſent a kind of picture to the mind.

Theſe images or pictures are of vaſt uſe to give weight, magnificence and ſtrength to a diſcourſe. They warm and animate it; and when managed with art, according to *Longinus*, ſeem, as it were, to tame and ſubdue the hearer, and put him in the power of the ſpeaker.

The ſame author recommends the *periphraſe* as of great uſe in a diſcourſe; which *periphraſe* is a circuit or tour of words, much affected by orators, to avoid common and trite manners of expreſſion.

The *periphraſe* is certainly of good uſe in many occaſions; and we are frequently forced to have recourſe to it, to make things be conceived which is not proper to name.

Thus *Cicero*, unable to deny that *Clodius* was ſlain by *Milo*, owns it, with this *periphraſe* or *circumlocution*: 'Milo's ſervants being prevented from 'aſſiſting their maſter, who was reported to be 'killed by *Clodius*, they, in his abſence, and with-'out his privity or conſent, did what every body 'would expect from their own ſervants on ſuch 'occaſions.'

The AMPLIFICATION is alſo of a very great uſe in *rhetorick*, and is part of a diſcourſe or ſpeech, wherein a crime is aggravated, a praiſe or commendation heightened, or a narration enlarged by an enumeration of circumſtances; ſo as to excite the proper emotions in the ſouls of the auditors.

Such is that paſſage in *Virgil*, where, inſtead of ſaying merely that *Turnus* died, he amplifies his death.

---------Aſt illi ſolvuntur frigore membra,
Vitaque cum gemitu fugit indignata ſub umbras.

There are two general kinds of *amplification*; the one of *things*, the other of *words*. The firſt is produced in divers manners; as, 1. By a multitude of definitions: Thus it is *Cicero* amplifies on hiſtory: *Hiſtoria eſt teſtis temporum, lux veritatis, vita memoriæ, magiſtra vitæ, nuntia vetuſtatis.* —2. By a multitude of adjuncts; of which we have a fine inſtance in *Virgil*'s lamentation for *Cæſar*'s death, by enumerating the many prodigies and monſters that either preceded or ſucceeded it. —*Vox quoque per lucos vulgo exaudita ſilentes, ingens, & ſimulcra modis pallentia miris viſa ſub obſcurum noctis; pecudeſque locutæ, infandum, ſiſtunt amnes, terræque debiſcunt, & mæſtum illachrymat templis ebur, æraque ſudant.*—3. By a detail of cauſes and effects.—4. By an enumeration of conſequences. —5. By compariſons, ſimilitudes, and examples, &c.—6. By the contracts of antithets, and rational inference.

Amplification by words is effected ſix ways.—1. By uſing metaphors.—2. By hyperboles.—3. By ſynonims.—4. By ſplendid and magnificent terms; as that of *Horace*, *Scandit æratas vitioſa navi cura nec turmas equitum relinquit, ocyor cervis, & agente nymbos ocyor Euro.*—5. By periphraſes, or circumlocutions.—6. By repetition.—To which may be added, by gradation.

The periods, numbers, figures, &c. are what compoſes what we call *diſcourſes*, or *orations*; ſince an oration is a ſpeech or harangue, framed according to the rules of oratory, and ſpoke in publick.

All the kinds of *orations* may be reduced to three heads, *viz. demonſtrative*, *deliberative*, and *judicial*.

To the *demonſtrative kind* belong, *panegyricks*, *genethliaca*, *epithalamia*, *epicedia*, *euchariſtiæ*, *epinicia*, and *congratulations*.

Panegyrick is an oration in praiſe of ſome extraordinary perſon, or virtue.

The places or ſources of *panegyricks* are chiefly the family, country, auguries at his birth, his virtues, the talents of his body, mind, honours, riches, manner of his death, and the conſequences thereof.

Genethliacum is a compoſition in verſe, on the birth of ſome prince, or other illuſtrious perſon; wherein the poet promiſes him great honours, advantages, ſucceſſes, victories, &c. by a kind of prophecy or prediction.

The *epicedion* is a poetical compoſition on the death of a perſon.

I have explained what is underſtood by *epithalamium*, in *poetry*.

The *epicedion* was a compoſition on occaſion of a victory obtained.

To the deliberative kind belongs *perſuaſion*, *diſſuaſion*, *exhortation*, and *commendation*.

And to the judicial kind belongs *accuſation*, *confirmation*, *confutation*, &c.

Confirmation is the third part of an oration, wherein the orator undertakes to prove by laws, reaſons, authorities, and other arguments, the truth of the propoſitions advanced in his narration.

Confirmation is either *direct* or *indirect*; the firſt confirms what the orator has to urge for ſtrengthening his own cauſe: the ſecond, properly called *confutation*, refels the oppoſite arguing of the adverſaries.

From this I'll proceed to the fourth and laſt part of our diviſion of *rhetoric*, *viz.* the *pronunciation*.

PRO-

Pronunciation.

The PRONUNCIATION, as underſtood in this place, conſiſts in regulating and varying the voice and geſture agreeably to the matter and words, ſo as more effectually to touch the hearers.

Pronunciation is the ſame with what we otherwiſe call *action*.

There are three things which come under the *pronunciation*; the *memory*, *voice*, and *geſture*.

The *memory* is a natural talent, which, though eſſential to the orator, is not, notwithſtanding, to be acquired by art.

The *voice* is alſo a very eſſential part of eloquence, ſince it contributes much towards diſcovering all the beauties of a diſcourſe or oration, without which it appears inanimate, or languid. A fine and ſonorous voice ſtrikes ſo agreeably the ear of the auditors, that it often penetrates the inmoſt receſſes of the heart, where it excites different ſorts of paſſions, according to the ſubject of the diſcourſe. The orator muſt always begin his diſcourſe with a gentle and moderate voice, raiſing it with diſcretion by degrees, as occaſion requires, in ſuch a manner that he may be always maſter thereof; expreſſing joy in a quite different manner than he would do ſorrow, avoiding above all things a tedious monottony, as well as thoſe exceſſive bawlings, more proper to ſtun the auditor, than to make him hear.

The *geſture* is a motion of the body, intended to ſignify ſome idea or paſſion of the mind; and it conſiſts principally in the action of the hand and face.

Action, in oratory, is an accommodation of the perſon of the orator to his ſubject; or a management of the voice and geſture, ſuited to the matter ſpoken or delivered. It is an addreſs to our external ſenſes; which it endeavours to move, and bring into its party, by a well concerted motion and modulation; at the ſame time that the reaſon and underſtanding are attacked by force of argument.

Quintilian gives us a ſyſtem of the rules of *action*, taken not only from the writers of antient orators, but from the beſt examples of the forum.

The force and effects of *action*, at leaſt as practiſed among the antients, appears to be very great; ſcarce any thing was able to withſtand it. *Demoſthenes* expreſſly calls it, 'the beginning, the 'middle, and the end of the orator's office;' and *Cicero* profeſſes, 'that it does not ſo much matter 'what the orator ſays, as how he ſays it.'

Every part of the body is by them liſted into the ſervice, and marſhalled in its proper place: the hand, the eye, head, neck, ſides, cheeks, noſtrils, lips, arms, ſhoulders, &c.—*Precipuum in actione caput eſt. Cum geſtu concordet, & lateribus obſequatur*, oculi, lachrymæ, ſupercilium, genæ, rubor.—*Non manus ſolum, ſed & nutus.—Dominetur autem maximè* vultus.—*Quin & in vultu* pallor.—*Nares, labia.*—Dentes, cervix, humeri, brachia.—Manus *vero, ſine quibus* truncæ eſſet actio.---- *Quintil.* xi. 3.

Demoſthenes and *Cicero* are the princes of antient eloquence; the one among the *Greeks*, the other among the *Romans*; becauſe they both wrote and ſpoke well. Their manner however was exceedingly different; the firſt being cloſe, ſtrong, nervous, conciſe, and ſevere, ſo that a word could not be ſpared: the latter copious, florid, and rich, ſo that a word could not be added.

It was objected to *Cicero*, that his eloquence was *Aſiatick*, that is, redundant, or ſtuffed with ſuperfluous words and thoughts.

Pericles was called *a torrent of eloquence*, *a thunderbolt of eloquence*. Pedants do not diſtinguiſh *eloquence*, from the heaping up of figures, the uſe of big words, and the rotundity of periods.

True *eloquence* depends principally on the vivacity of the imagination. In ſtrictneſs, it is not that which gives grace and ornament, but life and motion, to diſcourſe. Its mien is that of an amazon, not that of a coquette.

The authors of the *art of thinking* remark, that the rules of *eloquence* are obſerved in the converſations of people naturally *eloquent*, though they never think of them while they practiſe them. They practiſe thoſe rules becauſe they are *eloquent*, in order not to be *eloquent*.

The *eloquence* of the chair and pulpit, is much more difficult every where, but in *England*, than that of the bar. The obligation laid on the *Engliſh* clergy to read their ſermons, has entirely baniſhed *eloquence* from the pulpit; therefore much better *orators* are found at *Weſtminſter*, either in both houſes of parliament, or in the courts of judicature, than in the churches; whereas in other countries, *France* for example, the beſt orators are found in the chair or pulpit. It is true, that there are ſome perſons who read better than others, but ſtill it is but reading, for that can never be called preaching; and reading for reading, I had rather chuſe to read myſelf than to hear another read; ſince I cannot only read better pieces of *eloquence* than thoſe which are often read to me, but likewiſe enter better into the ſenſe of the author, and be thereby much more edified. If that prohibition of reciting ſermons by heart was taken off, the *Engliſh* pulpit would acquire a new luſtre, for no doubt but that there are as good orators among the *Engliſh* clergy, as among others, and we

ſhould

not ſee a kind of epidemical lethargy reigning in the churches.

But without confining ourſelves to a particular country, we muſt ſay, that *eloquence* has ſhared every where the fate of all other arts and ſciences, and has ſuffered a very great eclipſe ever ſince, like them, it has met with little or no encouragement: in fact, true eloquence is ſo little in vogue at preſent, that the beſt orator would ſcarce find an audience worthy of being ſpoke to; ridiculous diſcourſes, digeſted without art, order, or agreement, and ſtuffed with low thoughts, trivial expreſſions, and delivered in an indolence which had been capable only to excite the compaſſion, or perhaps the laughter of an honeſt *Roman* citizen, are almoſt the only ones we are entertained with at preſent, and can aſſemble a numerous audience. Not that I pretend that all diſcourſes are to be compoſed with a ſcrupulous regularity, according to all the rules of *rhetorick* heretofore explained; but they ſhould not be all neglected, ſince no body can claim the title of orator, without he be a rhetorician.

ROPE-MAKING.

ROPE-MAKING, is to ſpin twiſts, or ſtrings of hemp; and when ſpun, to twiſt them together, in a greater or leſs number, according to the thickneſs of the *rope*.

This ſpinning is done by the rope-maker, twiſting round him a certain quantity of coarſe hempen flax, faſtening one end thereof to the iron of a ſpinning-wheel made for the purpoſe, ſpinning it with his index, and thumbs of both hands, walking ſlowly backwards, *i. e.* his face turned towards the wheel, while another perſon turns it round, to twiſt what he ſpins.—This operation is done in a long alley, commonly called *rope-walk*; and there are placed in the walk, by intervals, racks to ſupport the ropes, and keep it tight, which otherwiſe, being arrived at a certain length, would fall to the ground, and thereby prevents the operation going forwards.

If the twiſt, or ſtring, which is ſpun, is uſed alone, without being joined with others, it muſt be twiſted harder than if it was to enter into the compoſition of another rope; though there is ſcarce any rope which has not ſeveral twiſts.

When the rope is made very thick, it is called a *cable*; and when very ſmall, a *cord*.

A CABLE, is a thick, long, three-ſtring'd rope, ordinarily of hemp, ſerving to hold ſhips firm at anchor.

Cable is not applied to ropes of leſs than three inches circumference.

Every *cable*, of whatever thickneſs it be, is compoſed of three ſtrands; each ſtrand of three twiſts; each twiſt of a certain number of caburns, or threads of rope-yarn, more or leſs, as the *cable* is to be thicker or ſmaller.

To make a *cable*, after forming the ſtrands, they uſe ſtaves, which they firſt paſs between the ſtrands, that they may turn the better, and be intertwiſted the more regularly together: And to prevent any entangling, a weight is hung at the end of each ſtrand. The cable being twiſted as much as needs, is untwiſted again three or four turns, that the reſt may the better retain its ſtate.

The number of threads each kind of *cable* is to be compoſed of, is ever proportion'd to its length and thickneſs; and it is by this number of threads, that its weight and value are aſcertained. A rope of three inches circumference, or one inch diameter, conſiſts of 48 ordinary threads, and weighs 192 pounds; one of 10 inches circumference of 485 threads, and weighs 1940 pounds; a *cable* of 20 inches, of 1943 threads, and weighs 7772 pounds. The ſeamen ſay, the *cable is well laid*, when it is well wrought or made.

SCULPTURE.

SCULPTURE, is the art of cutting or carving various figures or repreſentations in wood, ſtone, or other matter; as alſo of faſhioning wax, earth, plaiſter, &c. to ſerve as models or moulds, for the caſting of metalline figures.

Sculpture is divided into ſeveral branches, *viz.* *Statuary*; which is the art of making *ſtatues* only, either in wood, ſtone, ivory, plaiſter, &c. *Carving*; which is that of making *baſs-relievo's*, *feſtoons*, *cartouches*, *fret-work*, &c.

A STATUE is a piece of *ſculpture* in full relievo, repreſenting a human figure.

In ſtrictneſs, the term *ſtatue* is only applied to figures on foot, as that of king *James* II. at *White-*

hall; the word being formed from the *Latin ſtatura*, the ſize of the body; or from *ſtare*, to ſtand.

There are *allegorical*, *cyriatic*, *curule*, *equeſtrian*, *Greek*, *hydraulic*, *pedeſtrian*, *Perſian*, and *Roman ſtatues*.

Allegorical STATUE is that, which under a human figure, or other ſymbol, repreſents ſomething of another kind, as a part of the earth, a ſeaſon, age, element, temperament, hour, &c.

Cyriatick STATUE is the ſame with what we called in our treatiſe of architecture caryatides.

Curule STATUES are thoſe, which are repreſented in chariots drawn by two or four horſes; of which kind there were ſeveral in the circus's, hippodromes, &c. or in cars, as we ſee ſome with triumphal arches on antique medals.

Equeſtrian STATUE is that repreſenting ſome illuſtrious perſon on horſeback. As that famous one of *Marcus Aurelius* at *Rome*; that of King *Charles* I. at *Charing-Croſs*.

A *Greek* STATUE is a figure, that is naked and antique; it being in this manner the *Greeks* repreſented their deities, athletæ, of the olympick games, and heroes. The *ſtatues* of heroes were particularly called *Achillean ſtatues*, by reaſon of the great number of figures of that prince, in moſt of the cities of *Greece*.

Hydraulick STATUE is any figure placed as an ornament of a fountain, or grotto; or that does the office of a jet d'eau, a cock, ſpout, or the like, by any of its parts, or by any attribute it holds. The like is to be underſtood of any animal ſerving for the ſame uſe.

Pedeſtrian STATUE is a *ſtatue* ſtanding on foot. As that of King *Charles* II. and others in the *Royal Exchange*.

Perſian STATUES are taken notice of in the treatiſe of architecture, under the Letter A.

Roman STATUES is an appellation given to ſuch as are cloathed, and which receives various names from the various dreſſes. Thoſe of emperors with long gowns over their armour, were called *ſtatuæ paludatæ*; thoſe of captains and chevaliers, with coats of arms, *tharacatæ*; thoſe of ſoldiers with cuiraſſes, *loricatæ*; thoſe of ſenators and augurs, *trabeatæ*; thoſe of magiſtrates with long robes, *togatæ*; thoſe of the people with a plain tunica, *tunicatæ*; and laſtly, thoſe of women with long trains, *ſtolatæ*.

The *Romans* had another diviſion of *ſtatues*, into *divine*, which were thoſe conſecrated to the gods; as *Jupiter*, *Mars*, *Apollo*, &c.— *Heroes*, which were thoſe of the demi gods, as *Hercules*, &c. And *Auguſti*, which were thoſe of the emperors; as thoſe two of *Cæſar* and *Auguſtus*, under the portico of the capitol.

The figure, or portrait of a perſon in *relievo*, ſhewing only the head, ſhoulders, and ſtomach; the arms being lopped off, ordinarily placed on a pedeſtal or conſol, is called *buſt* or *buſto*.

The *buſt* is the ſame with what the *Latins* called *herma*, from the Greek *hermes*, *Mercury*; the image of that god being frequently repreſented in this manner among the *Athenians*. *Buſt* is alſo uſed, eſpecially among the *Italians*, for the trunk of a human body, from the neck to the hips.

The ſculptor has ſeveral chiſſels, all different in bigneſs and fineneſs; which they change in proportion as they go on with their work; the largeſt are uſed to prime it, before they lay their deſign on the block, whereof the *ſtatue* is to be made.

For *Sculpture on marble or ſtone*; the firſt thing they do, is out of a great block of marble to ſaw another of the ſize required, which is performed with a ſmooth ſteel ſaw without teeth, caſting water and ſand thereon from time to time: then they faſhion it, by taking off what is ſuperfluous with a ſtubbed point, and a heavy mallet; after this, bringing it near the meaſure required, they reduce it ſtill nearer with another finer point. They now uſe a flat cutting inſtrument, having two notches in its edge, or three teeth; then a chiſſel to take off the ſcratches the former has left. This laſt inſtrument they uſe with a deal of delicacy, giving thereby a ſoftneſs and tenderneſs to their figure; till at length taking raſps of different degrees of fineneſs, by degrees they bring their work into a condition for poliſhing.

To poliſh or make the parts ſmooth and ſleek, they uſe pumice-ſtone and ſmalt, then tripoli; and when a ſtill greater luſtre is required, a ſkin of burnt ſtraw.

To proceed more regularly, on the head of the model, they place an immovable circle, divided into degrees, with a moveable ruler, or index, faſtened in the center of the circle, and divided likewiſe into equal parts; from the end of the ruler hangs a thread with a plummet; which ſerves to take all the points to be transferred thence to the block of marble, from whoſe top hangs another plummet like that of the model. All which may be ſeen in our table of miſcellany.

Indeed there are ſome excellent ſculptors, who diſapprove of this method; urging that the ſmalleſt motion of the model changes their meaſures, for which reaſon they rather chuſe to take all their meaſures with their compaſſes.

The perfection of a *ſtatue*, either in wood, marble, ſtone, iron, &c. conſiſts chiefly in a fine attitude, beautiful parts imitating nature as near as poſſible, without any exaggeration either in the features, or the pronunciation of the members.

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The drapery, if there be any, well thrown, and with as few plaits as poſſible; ſince it is not ſo eaſy to make them imitate the natural with the chiſſel, as with the pencil: and a too great number of plaits in marble, ſtone, or plaſter, appear rather as the pipes of an organ, or the like, than plaits, never affecting to render the muſcles viſible in the naked, but in proportion as the age, ſex, or attitude of the perſon the figure is to repreſent, require it: for the muſcles are not to be ſo viſible in a woman as in a man, nor in a child, as in a man grown, nor in a figure ſuppoſed in an eaſy poſture, as in one ſuppoſed in a violent one: which is a fault ſeveral very good ſculptors are guilty of, pretending thereby to make connoiſſeurs admire the ſtrokes of their chiſſels, and the knowledge they have of anatomy.

Statues are ſaid to be figures alſo in *relievo*.

There are three kinds of *relievo*'s, viz. *alto-relievo*, *baſſo-relievo*, and *demi-relievo*. *Relievo* in general, or *relief*, *imboſſment*, being applied to a figure which projects or ſtands out, prominent from the ground or plain whereon it is formed; whether that figure be cut with the chiſſel, moulded, or caſt.

Alto-RELIEVO, *haut-relief*, or *high-relievo*, is when the figure is formed after nature, and projects as much as the life.

Baſſo-RELIEVO, *bas relief*, or *low-relievo*, is when the work is but raiſed a little from its ground; as we ſee in medals, and in the frontiſpieces of buildings, particularly hiſtories, feſtoons, foliages, and other ornaments in the frieze.

Demi-RELIEVO, is when one half the figure riſes from the plain, *i. e.* when the body of a figure ſeems cut in two, and one half is clapped on the ground. When in a *baſſo-relievo* there are ſome parts that ſtand clear out, detached from the reſt, the work is called a *demi-boſſe*.

The antiquity of ſculpture is paſt doubt; as the ſacred writings, the moſt antient and authentick monument we have of the earlieſt ages, mentions it in ſeveral places; witneſs *Laban*'s idols ſtolen away by *Rachel*, and the golden calf which the *Iſraelites* ſet up in the deſart, &c. but it is very difficult to fix the original of the art, and the firſt artiſts from prophane authors; what we read thereof being intermixed with fables, after the manner and taſte of thoſe ages.

Some make a maſter of *Sicyon*, named *Dibutades*, the firſt ſculptor; others ſay, the art had its origin in the iſle of *Samos*, where one *Ideaus* and *Theodorus* performed works of this kind long before *Dibutades*'s time. It is added that *Demaratus*, father of *Tarquin* the elder, firſt brought it into *Italy* upon his retiring thither; and that by means of *Euciparus* and *Eutygrammus*, two excellent workmen herein, who communicated it chiefly to the *Tuſcans*, among whom it was afterwards cultivated with great ſucceſs. They add that *Tarquin* ſent for *Taurianus*, one of the moſt eminent among them, to *Rome*, to make a ſtatue of *Jupiter*, &c. of baked earth; for the frontiſpiece of the temple of that deity.

About this time, there were many ſculptors, both in *Greece* and *Italy*, who wrought altogether in earth. Some of the moſt noted are *Chalceſthenes* an *Athenian*, who made himſelf and his houſe famous, by the great number of earthen figures he adorned it withal; and *Demophilus* and *Gorſanus*, two painters, who enriched the temple of *Ceres* with great variety of painting and earthen images. In effect, all the firſt ſtatues of the heathen deities, were either of earth or wood; and it was not ſo much any frailty of the matter, or unfitneſs for the purpoſe, as the riches and luxury of the people, that firſt induced them to make images of marble, and other more precious ſtone.

Indeed how rich ſoever the matter were whereon they wrought, yet they ſtill uſed earth, to form models thereof: and to this day, whether they be for cutting marble ſtatues with the chiſſel, as already obſerved, or for caſting them in metal: they never undertake the one or the other, without firſt making a perfect model thereof in earth.

Phidias of *Athens*, who came next, ſurpaſſed all his predeceſſors, both in marble, in ivory, and metals: and about the ſame time appeared ſeveral others, who carried ſculpture to the higheſt perfection it ever arrived at, particularly *Policletus* at *Sicyon*; then *Migron*; *Lyſippus*, who alone was allowed the honour of caſting *Alexander*'s image in braſs: *Praxiteles* and *Scopas*, who made thoſe excellent figures now before the pope's palace, at *Monte Cavallo*: *Briacus*, *Timotheus*, and *Leothares*, who with *Scopas* wrought the famous tomb of *Mauſoleus* King of *Caria*; *Caphiſſodotus*, *Canachus*, *Dadalus*, *Bathicus*, *Nicetratus*, *Euphranor*, *Theodorus*, *Xenarates*, *Pyromachus*, *Itratonicus*, *Antigonus*, who wrote on the ſubject of his art; the famous authors of *Laocoon*, viz. *Ageſander*, *Polydore*, and *Athenodorus*, and infinite others, the names of ſome whereof have paſſed to poſterity.

When *Marcus Scaurus* was Ædile, his office obliging him to provide what was requiſite towards the public rejoicings, he adorned the ſtately theatre which he erected with 3000 braſs ſtatues; and though *L. Mummius* and *Lucullus*, brought away a great number out of *Aſia* and *Greece*, yet there were ſtill above 3000 remaining in *Rhodes*, as many at *Athens*, and more at *Delphos*.

But what is more extraordinary was the bigneſs of the figures, which thoſe antient artiſts had the

courage to undertake: among thoſe *Lucullus* brought to *Rome*, there was one of *Apollo* 30 cubits high; the *Coloſſus* of *Rhodes* made by *Gares* of *Lyndes*, the diſciple of *Lyſippus* far exceeding it; *Nero*'s ſtatue, made by *Xenodorus*, after that of *Mercury*, was 110 feet high.

Sculpture however did not continue above 150 years after *Phidias's* time, till it began inſenſibly to decline; not but that there were ſtill ſome fine pieces of workmanſhip both in *Greece* and *Italy*, though not performed with ſo good a fancy, and ſuch exquiſite beauty as thoſe of the former works. Beſides that the *Greek* ſtatues are moſt eſteemed for the workmanſhip; there is a ſpecial difference between them and thoſe of the *Romans*, in that the greateſt part of the firſt are naked, like thoſe who wreſtle, or perform ſome other bodily exerciſe, wherein the youth of thoſe times placed all their glory; whereas the others are clad or armed, and particularly have the toga on, which was the greateſt mark of honour among the *Romans*.

SHAMOISING.

SHAMOISING is the art of preparing ſheep, goat, or kid-ſkin, in oil, in imitation of *ſhammy*. Which *ſhammy* is the ſkin of the *chamois* or *ſhamois*, a kind of wild goat, called *iſard*, inhabiting the mountains of *Dauphiné*, *Savoy*, and the *Pyreneans*.

Beſides the ſoftneſs and warmneſs of the leather, it has the faculty of bearing ſoap without damage, which renders it very uſeful on many accounts.

To counterfeit this ſort of leather, the ſkins of any of the other animals above-mentioned, being waſhed, drained, and ſmeared over with quick-lime on the fleſhy ſide, are folded in two, lengthwiſe, the wool outwards, and laid on heaps; and ſo left to ferment eight days; or if they have been left to dry after flaying, fifteen days.

Then they are waſhed out, drained, and half dried, laid on a wooden leg or horſe, the wool ſtripped off with a round ſtaff for the purpoſe, and laid in a weak pit, the lime whereof had been uſed before, and had loſt the greateſt part of its force.

After twenty-four hours they are taken out, and left to drain twenty-four more; then put in another ſtronger pit. This done, they are taken out, drained, and put in again by turns; which begins to diſpoſe them to take oil; and this practice they continue for ſix weeks in ſummer, or three months in winter; at the end whereof they are waſhed out, laid on the wooden leg, and the ſurface of the ſkin on the wool-ſide pulled off, to render them the ſofter; then made into parcels, ſteeped a night more in the river, in winter; ſtretching ſix or ſeven over one another, on the wooden leg; and the knife paſſed ſtrongly on the fleſh-ſide, to take off any thing ſuperfluous, and render the ſkin ſmooth.

Then they are ſtretched as before in the river; and the ſame operation repeated on the wool ſide; then thrown into a tub of water with bran in it, which is brewed among the ſkins till the greateſt part ſtick to them; and then ſeparated into diſtinct tubs, till they ſwell, and riſe of themſelves above the water.

By this means the remains of the lime are cleared out: they are then wrung out, hung up to dry on ropes, and ſent to the mill, with the quantity of oil neceſſary to ſever them. The beſt oil is that of ſtock-fiſh.

Here they are firſt thrown in bundles into the river, for twelve hours; then laid in the mill-trough, and fulled without oil till they be well ſoftened; then oiled with the hand, one by one, and thus formed into parcels of four ſkins each, which are milled, and dried on cords a ſecond time, then a third, then oiled again and dried.

This proceſs is repeated as often as neceſſity requires: when done, if there be any moiſture remaining, they are dried in a ſtove, and made up into parcels wrapped up in wool: after ſome time they are opened to the air, but wrapped up again as before, till ſuch a time as the oil ſeems to have loſt all its force, which it ordinarily does in twenty-four hours.

The ſkins are then returned from the mill to the *ſhamoiſer*, to be ſcoured, which is done by putting them in a lixivium of wood-aſhes, working and beating them in it with poles, and leaving them to ſteep till the lye has had its effect; then they are wrung out, ſteeped in another lixivium, wrung again, and this repeated till all the greaſe and oil be purged out. When this is done, they are half dried, and paſſed over a ſharp-edged iron inſtrument, placed perpendicular on a block, which opens, ſoftens, and makes them gentle: laſtly, they are thoroughly dried, and paſſed over the ſame inſtrument again, which finiſhes the preparation, and leaves them in form of *ſhammy*.

Kid and goat-ſkins are *ſhamoiſed* in the ſame manner as thoſe of ſheep; excepting that the hair is taken off, without the uſe of any lime; and that when brought from the mill, they undergo a

particular

particular preparation, called *ramalling*; the moſt delicate and difficult of all others.

It conſiſts in this; that as ſoon as brought from the mill, they are ſteeped in a fit lixivium; taken out, ſtretched on a round wooden leg, and the hair ſcraped off with the knife; this makes them ſmooth, and in working caſt a kind of fine nap. The difficulty is in ſcraping them even.

There is, likewiſe, an art or manner of preparing, or dreſſing ſkins in white, to fit them for uſe in divers manufactures, particularly gloves, purſes, *&c.* which art is called *tawing*.

All kinds of ſkins may be *tawed*; but it is chiefly thoſe of ſheep, lambs, kids, and goats, that are uſed to be dreſſed this way; as being thoſe fitteſt for gloves.

As to the *method of tawing, or drawing ſkins in white.* The wool or hair being well got off the ſkins by means of lime, *&c.* as above deſcribed, they are laid in a large vat of wood or ſtone ſet in the ground, full of water, wherein quick-lime has been ſlacked; wherein they continue a month or ſix weeks, as the weather is more or leſs hot; or as the ſkins are requir'd to be more or leſs ſoft and pliant.

While in the vat, the water and lime is changed twice, and they are taken out and put in again every day. When taken out for the laſt time, they are laid all night to ſoak in a running water, to get out the greateſt part of the lime; and in the morning are laid ſix together on the wooden leg, to get off the fleſh by ſcraping them ſtoutly, one after another, on the fleſh ſide, with a cutting two-handed inſtrument, called a knife; and while this is in hand, they cut off the legs, and other ſuperfluous parts about the extremes.

This done, they are laid in a vat or pit, with a little water, where being well fulled with wooden peſtles for a quarter of an hour, the vat is filled up with water, and the ſkins rinſed therein. They are next thrown on a clean pavement to drain; which done, they are caſt into a freſh pit of water, where being well rinſed, they are taken out, and laid on the wooden leg, ſix at once, with the hair ſide outermoſt, over which they rub a kind of whetſtone very briſkly, to ſoften and fit them to receive four or five more preparations given them on the leg, both on the fleſh ſide and the hair ſide, with the knife, after the manner above-mentioned.

This over, they are put in a pit with water, and wheat-bran, and ſtirred about therein, with wooden poles, till the bran is perceived to ſtick to them, and then they are left; as they raiſe of themſelves to the top of the water by a kind of fermentation, they are plunged down again to the bottom; and, at the ſame time, fire is ſet to the liquor, which takes as eaſily as if it was brandy, but goes out the moment the ſkins are all cover'd.

This operation is repeated as often as the ſkins riſe above water; and when they riſe no more, they are taken out, laid on the wooden leg, the fleſh ſide outermoſt, and the knife paſſed over it to ſcrape off the bran. The bran thus cleared, the ſkins are laid in a large baſket, where they are loaden with huge ſtones to promote their draining; and when ſufficiently drained, their feeding is given them, which is performed after the following manner.

For a hundred large ſheep-ſkins, and for ſmaller in proportion, they take eight pounds of allum, and three of ſea-ſalt, and melt the whole with water over the fire; pouring the diſſolution out, while yet lukewarm, into a kind of trough, wherein is twenty pounds of fine wheat flour, with eight dozen yolks of eggs; of all which is formed a kind of paſte, a little thicker than children's pap, which, when done, is put into another veſſel, to be uſed in manner following.

A quantity of hot water being poured into the trough, wherein the paſte was prepared, two ſpoonfuls of the paſte is mixed therewith; in order to which they uſe a wooden ſpoon, which contains juſt what is required for a dozen ſkins: and when the whole is well diluted, two dozen of the ſkins are plunged therein: care being taken, by the way, that the water be not too hot, which would ſpoil the paſte, and burn the ſkins.

Having ſtaid ſome time in the trough, they are taken out one after another with the hand, and ſtretched out, which is repeated twice: when they have all had their paſte, they are put into tubs, where they are fulled afreſh with wooden peſtles.

Then they are put in a vat, where they remain five or ſix days or more, and are at laſt taken out in fair weather, and hung out to dry on cords or racks: the quicker they dry, the better; for if they be too long a drying, the ſalt and allum within them are apt to make them riſe into a grain, which is an eſſential fault in this kind of dreſſing.

When the ſkins are dry, they are put up in bundles, and juſt dipp'd in fair water; from which being taken out and drained, they are thrown into an empty tub; and after ſome time, are taken out, and trampled under foot.

They are then drawn over a flat iron inſtrument, the top whereof is round like a battledore, and the bottom fixed into a wooden block, to ſtretch and open them: when open, they are hung in the air upon cords to dry; and when dry, are open a

ſecond time by repaſſing them over the ſame inſtrument.

Laſtly, they are laid on a table, pulled out, and laid ſmooth; and are thus in a condition for ſale and uſe. After the ſame manner are dreſſed horſes, cows, calves ſkins, *&c.* for ſadlers, harneſs-makers, *&c.* as alſo dogs, wolves, bears ſkins, *&c.* excepting that in thoſe the uſe of the paſte is omitted; ſalt and allum-water being ſufficient.

It will not be improper to add here the manner of preparing *ſhagreen*, which is a kind of grain-leather, chiefly uſed on the cover of caſes, books, *&c.* it is very cloſe and ſolid, and cover'd over with little roundiſh grains or papillæ.

As to the preparation thereof. The ſkin being juſt flayed off, is ſtretched out, cover'd over with muſtard-ſeed, and the ſeed bruiſed on it, and thus expoſed to the weather for ſome days, then tanned.

The beſt is that brought from *Conſtantinople*, of a browniſh colour; the white is the worſt. It is extremely hard, yet when ſteeped in water becomes very ſoft and pliable; whence it becomes of great uſe among caſe-makers. It takes any colour that is given it; red, green, yellow, or black. It is frequently counterfeited by *maroquin*, formed like *ſhagreen*; but this laſt is diſtinguiſhed by its peeling off, which the firſt does not.

There is alſo a kind of *ſhagreen* made of the ſkin of the *ſquatina*; in *Engliſh*, the monk or angel fiſh.

There is a diſpute among authors, what the animal is whence the *ſhagreen* is prepared. *Rauwolf* aſſures us, it is the *onager*, which, according to him and *Bellonius*, is a kind of *wild aſs*.

It is added, that it is only the hard part of the ſkin is uſed for this purpoſe. *Boul* ſays it is a *ſea-calf*; others, a kind of fiſh, called by the *Turks* *ſhagreen*, whoſe ſkin is cover'd with grains, and thoſe ſo hard, that they will raſp and poliſh wood.

Shagreen is brought from *Conſtantinople*, *Tauris*, *Tripoli*, *Algiers*, and ſome parts of *Poland*.

SMITHERY.

SMITH is an appellation given to artiſts who forge and prepare ſome metal on the anvil, particularly gold, ſilver, iron, copper, *&c.* therefore there are *goldſmiths*, *ſilverſmiths*, *blackſmiths*, *copperſmiths*, &c.

There is no other difference between a goldſmith and a ſilverſmith, but in the appellation, for commonly the ſame artiſt works both metals.

The workſhop of a gold or ſilverſmith, muſt be fitted with a forge, crucibles of different ſizes, anvils, hammers, moulds, vices, files, poliſhers, burniſhers, *&c.*

Gold and ſilver are never worked pure, but are always mixed with their proper alloy, which for gold, is ſilver and copper; and for ſilver, copper alone; but in mixing thoſe metals, they muſt be kept to the ſtandard.

The ſtandard of gold in *England*, *France* and *Flanders*, is 22 carats of fine gold, and a carat of alloy in the pound weight troy. And the ſtandard of ſilver is 11 ounces and two penny weights of ſilver, and 18 penny weights of alloy of copper.

Gold and ſilver, before they are forged, are reduced into ingots; and the ingenious artiſt, having took enough of it for the piece of work he intends to make, he heats it red-hot in his forge, as a blackſmith does his iron, to render it more ductile, compact and more proper for farther preparations. This firſt operation is the foundation, of the whole beauty of the work. For if the metal be not well forged, at firſt, it remains brittle and fragile, *i. e.* that it breaks eaſily under the hands of the artiſt, when he is giving the form it muſt have; or of thoſe who have bought it; whereas when well forged it bends all manner of ways, without breaking. But there is a great art in forging it; for the metal muſt neither be heated too much, nor too little, nor too often, nor hammered too hard; for if it be heated too hot, it ſcales by too great abundance of the igneous particles, which crowd into the parts of the metal with too much impetuoſity lacerating their texture; and if not heated enough, it reſiſts to the hammer for want of a ſufficient quantity of igneous particles, to help, by their rotation, accellerated by the motion of the hammer, towards the dilatation of the pores: therefore the metal muſt never be left in the fire till it emits a kind of ſtars when taken out; neither is it to be taken out while it appears cloudy.

The artiſt muſt likewiſe take a particular care to hammer it evenly, *i. e.* without leaving part of its metal very prominent while he is flattening the other. In forging, the hammer muſt not be let fall too heavy on the metal; for dilating thereby its pores with too much violence, it makes them burſt, whereby they run into one another, and prevents the concatenation neceſſary, to render it pliable and manageable.

If

SILVER-SMITHS SHOP.

...a piece of work, which must be planed ...old, after it has been forged; that planing must ...done with a fresh and even hand, with very ...tle violence, taking the ridges successively, one ...ral another; and it is the second piece of work, ...ng round-wise, beginning at the edges, ...and going ...wards the middle.

When a piece-work, after it has been forged, ...ld be, it be a large piece, the filing must ...be done with bold and long strokes, which contribute much to the beauty of the work, ...ps towards its being polished with much more ...ase.

The pieces of work which are to be cast, ...re cast either in sand, if they be large pieces, or ...in the bones, or the cuttle-fish, if they be small ...ones; which they do by pressing the pattern between two bones, and leaving a jet or ...le to convey the silver through after the pattern has been ...ken out.

If the work consists of several pieces, they are ...ldered together.

Goldsmiths ...make for their kinds of solder: ...a solder of copper to seven parts of silver ...there is one of brass or copper. Solder of this ...where to ...y a ...vith part b copper. Solder of four, ...and lo...er of three. It is the mixture of copper ...in the ...r that makes gilded plate always come ...cheaper than ...

To ...lder the pieces they soften them with borax ...perhaps with a piece of iron wire, and they cover ...with pieces of ...older and some borax, that part ...where the pieces are to be joined: then if it be a ...piece of work, they put it on a piece of charcoal, ...and having lighted a lamp or a big candle, ...and ...olding their work in the left-hand, and as ...the ...ame as possible, they with the right ...having their pipe, blow through it into the flame, ...which ...s spread over the work, and melts ...the ...older, when by ...s are soldered together. When the ...ces the solder to ...g, he ...them in the ...room the lamp, and the pieces ...are ...ard after with ...file the inequalities, ...so ...ly, that ...little discernable as possible. ...ontains the great secret of the art ...of ...

The work in this condition is fit for polishing; which is done ...a fine piece of white wood and ...olcothar. ...When polishing it is burnished with a rounded ...olished piece of steel, which last operation gives a lustre to the metal. If it be gold it is coloured ...as the ...manner ...have explained in our ...treatise ...under the letter G.

Jewelry is nothing to be thrown away upon

come out of gold or silver, all the alloys of the ...ces and tweepings of the work-shop, are carefully ...ved, in order to recover by washing the particles of gold and silver out of them; which is performed by simply washing them again and again, or by putting them in the washing-mill.

To make one of those washes, they put only ...gether together the alloys of the pieces, and the ...weepings of the work-bench; they also found an ...brick the old earthen crucibles, and the very ...bricks ...hereof the furnaces are built, little particles of gold, ...being found to stick to them, by the cracking nature of the metals when in ...their vast degree of heat.

These matters being all well ground and mixed together, are put ...to large wooden bolters, where they are washed several times, and in several waters, which run off by inclination into troughs underneath; carrying with them the earth, and the inclosed particles of the metal, and only leaving behind them the ...ir and whatever earthy ones, which are visible to the eye, are taken out with the hand, without any more trouble.

To get out the finer parts got on with the earth, they use ...ad, and a washing mill. This mill consists of a large wooden trough, at the bottom of which are two metaline parts, serving like mill-stones; the lower being convex, and the upper, which is in form of a crab, con-

...-top is a winch, placed horizontally, which ...rns the upper piece round; and at the bottom a ...bung, to let out the water and earth when turned ...ciently ground.

To have a wash then, the trough is filled with common water, into which they cast thirty or forty pounds of quicksilver, and two or three gallons of the matter remaining after the first operation. Then turning the winch, they give motion to the upper mill-stone; which grinding the matter and the quicksilver violently together, the particles of gold and silver become more easily amalgamated therewith: This work they continue for two hours; when ...ning the bung, the water and ...th ...n out, and a fresh quantity is put in.

The earths are usually washed thus through the mill three times, and the same quantity of mercury usually serves in the three times. When there is nothing left in the mill but the mercury, united with the gold and silver which it has amalgamated, they take it out, and washing it in divers ...ley put it in a thick bag, and lay it ...to squeeze out the water and the loose quicksilver: the remaining quicksilver they evaporate by fire in a retort, or an alembick. The

If it be a piece of work, which muſt be planed cold, after it has been forged; that planing muſt be done with a ſteady and even hand, with very little violence, taking the ridges ſucceſſively, one after another: and if it be a round piece of work, planing round-wiſe; beginning next the edges, and going on progreſſively towards the middle.

When a piece-work, after it has been forged, is to be filed, if it be a large piece, the filing muſt be done with bold and long ſtrokes, which contributes much to the beauty of the work, and helps towards its being poliſhed with much more eaſe.

The pieces of works, which are to be caſt, are caſt either in ſand, if they be large pieces, or in the bones of the ſcuttle-fiſh, if they be ſmall ones; which they do by preſſing the pattern between two bones; and leaving a jet or hole to convey the ſilver through after the pattern has been taken out.

If the work conſiſts of ſeveral pieces, they are ſoldered together.

Goldſmiths uſually make four kinds of ſolder, *viz.* ſolder of eight, where to ſeven parts of ſilver there is one of braſs or copper. Solder of ſix, where only a ſixth part is copper. Solder of four, and ſolder of three. It is the mixture of copper in the ſolder that makes raiſed plate always come cheaper than flat.

To ſolder the pieces they faſten them tight together with a piece of iron wire, and they cover with pieces of ſolder and ſome borax, that part where the pieces are to be joined: then if it be a ſmall piece of work, they put it on a piece of charcoal, and having lighted a lamp or a big candle, and holding their work in the left-hand, and as near the flame as poſſible, they with the right holding their pipe, blow through it into the flame, which makes it ſpread over the work, and melt the ſolder, whereby the pieces are ſolder'd together. When the artiſt ſees the ſolder fuſing, he takes his work from the lamp, and the operation is done; taking off afterwards with a file the ſuperfluidity of the ſolder; ſo dexterouſly, that the ſoldered part may be as little diſcernable as poſſible; in which conſiſts the great ſecret of the art of ſoldering.

The work in this condition is fit for poliſhing; which is done with a piece of white wood and tripoli. When poliſhed it is burniſhed with a round poliſhed piece of ſteel; which laſt operation gives a luſtre to the metal. If it be gold it is coloured in the ſame manner we have explained in our treatiſe of *gilding*, under the letter G.

As there is nothing to be thrown away of what comes out of gold or ſilver, all the aſhes of the furnaces and ſweepings of the work-ſhop, are carefully ſaved, in order to recover by waſhing the particles of gold and ſilver out of them; which is performed by ſimply waſhing them again and again, or by putting them in the waſhing-mill.

To make one of thoſe waſhes, they not only gather together the aſhes of the furnaces, and the ſweepings of the work-houſes; but they alſo pound and break the old earthen crucibles, and the very bricks whereof the furnaces are built; little particles of gold, *&c.* being found to ſtick to them, by the crackling nature of thoſe metals when in their vaſt degree of heat.

Theſe matters being all well ground and mixed together, are put in large wooden baſons, where they are waſhed ſeveral times, and in ſeveral waters, which run off by inclination into troughs underneath; carrying with them the earth, and the inſenſible particles of the metals; and only leaving behind them the larger and more conſiderable ones, which are viſible to the eye, and taken out with the hand, without any more trouble.

To get out the finer parts gone off with the earth, they uſe quickſilver, and a waſhing mill. This mill conſiſts of a large wooden trough, at the bottom of which are two metalline parts, ſerving like mill-ſtones; the lower being convex, and the upper, which is in form of a croſs, concave.

A-top is a winch, placed horizontally, which turns the upper piece round; and at the bottom a bung, to let out the water and earth when ſufficiently ground.

To have a waſh then, the trough is filled with common water, into which they caſt thirty or forty pounds of quickſilver; and two or three gallons of the matter remaining after the firſt lotion. Then turning the winch, they give motion to the upper mill-ſtone; which grinding the matter and the quickſilver violently together, the particles of gold and ſilver become more eaſily amalgamated therewith: This work they continue for two hours; when opening the bung, the water and earth run out, and a freſh quantity is put in.

The earths are uſually paſſed thus through the mill three times; and the ſame quantity of mercury uſually ſerves all the three times. When there is nothing left in the mill but the mercury, united with the gold and ſilver which it has amalgamated, they take it out, and waſhing it in divers waters, they put it in a thick bag, and lay in a preſs to ſqueeze out the water and the looſe quickſilver: the remaining quickſilver they evaporate by fire in a retort, or an alembick. The

metal which remains they refine with lead, or part it with aqua fortis, as deſcribed in my treatiſe of *refining*, under the letter R.

As for *black-ſmiths*, their workſhop muſt likewiſe be fitted with a forge, anvils, and hammers, of different ſizes, files, vices, *&c.*

The forge of a blackſmith, as likewiſe of the ſeveral other operators in iron, is very ſimple.

The hearth, or fire-place, is a maſs of bricks about two feet ſix inches high: the back of the forge is built upright to the cieling, and is incloſed over the fire-place with a hovel, which leads into a chimney to carry away the ſmoak. In the back of the forge, againſt the fire-place, is a thick iron plate, with a taper fixed therein, about five inches long, called the *tewel*, into which the noſe or pipe of the bellows is received: the uſe of this plate and tewel is, to preſerve the pipe of the bellows, and the back of the hearth from being burnt. Right before the back, at about two feet diſtance, is the trough filled with water, to wet the coals in, and thereby increaſe their force; as alſo to punch the iron in. Behind the back of the forge is placed the bellows, one of whoſe boards is fixed ſo that it moves not either upwards or downwards; and to the other is fixed a rope, chain, or even rod; which riſing perpendicularly, is fixed to a croſs piece, called the *rocker*, which moving on a kind of fulcrum near the middle, ſerves as a handle.

By drawing down this handle, the moveable board of the bellows riſes; and by a conſiderable weight atop of its upper board, ſinks it down again; and by this alternate agitation performs the office of a pair of bellows.

Braziers and copper-ſmiths forge differs but little from that already deſcribed, unleſs that it is much leſs, and that nothing is burnt in it but charcoal; the metals uſed by theſe operators not being able to ſuſtain the violence of pit-coal.

Iron is hammered and forged two ways, either by the force of the hand, in which there are uſually ſeveral perſons employed, one of them turning the iron, and hammering likewiſe, and the reſt only hammering.

Or by the force of a water-mill; which riſes, and works ſeveral huge hammers beyond the force of man, under the ſtrokes whereof the workmen preſent lumps, or pieces of iron, which are ſuſtained at one end by the anvils, and at the other by iron chains faſtened to the cieling of the forge.

This laſt way of forging is only uſed in the largeſt works, as anchors for ſhips, *&c.* which uſually weigh ſeveral thouſand pounds. For lighter works, a ſingle man ſuffices to hold, heat, and turn with one hand, while he ſtrikes with the other. Each purpoſe the work is deſigned for requires its proper heat. If it be too cold, it will not feel the weight of the hammer, as the *ſmiths* call it (*i. e.* will not ſtretch or give way) and if it be too hot, it will red-ſcar, *i. e.* break, or crackle under the hammer.

The ſeveral heats the *ſmiths* give their iron, are, 1. A blood-red heat. 2. A white flame-heat, 3. A ſparkling or welding heat.

SOAP-MAKING.

SOAP-MAKING is the art of preparing a kind of paſte, ſometimes hard and dry, and ſometimes ſoft and liquid; much uſed in waſhing and whitening linen; and for various other purpoſes by the dyers, perfumers, hatters, fullers, *&c.*

There are three principal ſorts of *ſoap* manufactured in *England*, viz. the *ſoft*, the *hard*, and the *ball-ſoap*. The ſoft ſoap again is either white or green.

The chief ingredients uſed in making the green ſoft ſoap, are lyes drawn from pot-aſh and lime, boiled up with Tallow and oil. Firſt, the lye and tallow are put into the copper together; and when melted, the oil is put to it, and the copper made to boil; then the fire is dampt or ſtopt up, while the ingredients lie in the copper to knit or incorporate; which done, the copper is ſet on boiling, being fed or filled with lyes, as it boils, till there be a ſufficient quantity put therein: then it is boiled off with all convenient ſpeed, and put into caſks.

There are two ſorts of *white ſoap*; one ſort thereof is made after the ſame manner as *green ſoft ſoap* is, oil excepted, which is not uſed in white. The other ſort is made from lyes of aſhes of lime boiled up at twice with tallow.

Firſt, a quantity of lye and tallow are put into the copper together, and kept boiling; being fed with lye as it boils, until it grains, or is boiled enough; then the lyes are ſeparated or diſcharged from the tallowiſh part, which part is removed into a tub, and the lyes thrown away: this is called the firſt half boiled. Then the copper is charged again with freſh tallow and lyes, and the firſt half boil'd put out of the tub into the cop-

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per a ſecond time; where it is kept boiling with freſh lyes and tallow till it comes to perfection. It is then put out of the copper into the ſame ſort of caſks, as are uſed in green ſoft ſoap.

As to *hard ſoap*.---It is made with lyes from aſhes and tallow, and moſt commonly boiled at twice: the firſt called a half boiling, has the ſame operation as the firſt half-boil'd of ſoft white ſoap. Then the copper is charged with freſh lyes again, and the firſt half-boil'd put into it, where it is kept boiling, and fed with lyes as it boils, till it grains, or is boiled enough; then the lye is diſcharged from it, and the *ſoap* put into a frame to cool and harden. There is no certain time for bringing off a boiling of any of theſe ſorts of *ſoap*; it frequently takes up part of two days.

The *ball ſoap* is made with lyes from aſhes and tallow. The lyes are put into the copper, and boiled till the watery part is quite gone, and there remains nothing in the copper but a ſort of nitrous matter (the very ſtrength or eſſence of the lye;) to this the tallow is put, and the copper kept boiling, and ſtirring for about half an hour, in which time the *ſoap* is made; and then it is put out of the copper into tubs or baſkets with ſheets in them; and immediately (while ſoft) made into balls. It requires near twenty-four hours to boil away the watery part of the lye.

The *ſoft ſoap* is the moſt common in *England*, and the beſt.

Soft ſoap is an excellent remedy to kill crab lice, by rubbing the part with it.

STARCH-MAKING.

STARCH-MAKING is the art of procuring a ſediment from wheat which had been ſteeped in water; of which ſediment, after ſeparating the bran from it, by paſſing it through ſieves, are formed a kind of loaves, which being dried in the ſun, or an oven, is afterwards broke into little pieces, and ſo ſold. The proceſs is as follows:

The grain being well cleaned, is put to ferment in veſſels full of water, which they expoſe to the ſun, when in its greateſt heat; changing the water twice a day for the ſpace of eight or twelve days, according to the ſeaſon. When the grain burſts eaſily under the finger, they judge it ſufficiently fermented. The fermentation perfected, and the grain thus ſoftened; it is put, handful by handful, in a canvas bag, to ſeparate the flour from the huſks, which is done by rubbing and beating it on a plank, laid a-croſs the mouth of the empty veſſel, that is to receive the flour.

As the veſſels are filled with this liquid flour, there is ſeen ſwimming a-top, a reddiſh water, which is to be careſully ſcum off from time to time, and clean water put in its place; which, after ſtirring the whole together, is all to be ſtrained through a cloth or ſieve, and what is left behind, put into the veſſel with new water, and expoſed to the ſun for ſome time; and as the ſediment thickens at the bottom, they drain off the water four or five times, by inclining the veſſel, but without paſſing it through the ſieve. What remains at the bottom, is the *ſtarch*, which they cut in pieces to get out, and leave it to dry in the ſun. When dry it is laid up for uſe.

The beſt *ſtarch* is white, ſoft, and friable, eaſily broke into powder.

Starch is uſed along with ſmalt, or ſtone blue, to ſtiffen and clear linen. The powder thereof is alſo uſed to whiten and powder the hair.

It is alſo uſed by the dyers to diſpoſe their ſtuffs to take colours the better.

STEREOMETRY.

STEREOMETRY is the art of meaſuring ſolid bodies, *i. e.* of finding the ſolidity or ſolid contents of bodies, as globes, cylinders, cubes, veſſels, ſhips, &c.

Solidity, as underſtood here, is the quantity of ſpace, contained in a ſolid body; called alſo the ſolid content, and the cube thereof.

To *meaſure the ſurface, and ſolidity of a priſm*; find the area of the baſe, and multiply it by 2; find the areas of the planes, or parallelograms, that include or circumſcribe it, and add their ſum to the former product. The ſum is the whole ſurface of the *priſm*.

Multiply then the baſe by the altitude; the product is the ſolidity of the cube.

All *priſms* are in a ratio compounded of their baſes and attitudes: If then their baſes be equal, they are to each other as their heights; and *vice virſâ*. Similar *priſms*, &c. are in a triplicate

ratio of their homologous sides, as also of their altitudes.

To *measure the surface and solidity of a pyramid.*—Find the solidity of a prism, that has the same base with the given pyramed; and divide this by three; the quotient will be the solidity of the *pyramid*.

Suppose *v. gr.* the solidity of the prism be found 6701328, the solidity of the *pyramid* will be thus found 22336770.

The surface of a pyramid is had by finding the areas both of the base, and of the lateral triangles. The sum of these is the area of the *pyramid*.

The external surface of a right *pyramid*, standing on a regular poligonal base, is equal to the altitude of one of the triangles which compose it, multiplied by the whole circumference of the base of the *pyramid*.

A *sphere* is equal to a pyramid, whose base is equal to the surface, and its height to the radius of the *sphere*.

Hence a *sphere* being esteemed such a pyramid, its *cube* or *solid content* is found like that of a pyramid.

2. A *sphere* is to a cylinder, standing on an equal basis, and of the same height, as 2 to 3. Hence also may the cube or content of the *sphere* be found.

3. The cube of the diameter of a sphere, is to the solid content of the *sphere*, nearly as 300 to 157; and thus also may the content of the *sphere* be measured.

4. The surface of a *sphere* is quadruple the area of a circle described with the radius of the *sphere*. For since a *sphere* is equal to a pyramid, whose base is the surface, and its altitude the radius of the *sphere*: the surface of the *sphere* is had by dividing its solidity by a third part of its diameter. If now the diameter of the circle be 100, the area will be 7850; consequently the solidity 1570000; which divided by a third of the semi-diameter, 100, the quotient is the surface of the *sphere* 31400, which is manifestly quadruple the area of the circle.

The *diameter of a sphere being given to find its surface and solidity*. Find the periphery of the circle described by the radius of the *sphere*. Multiply this, found, into the diameter; the product is the surface of the *sphere*. Multiply the surface by a sixth part of the diameter, the product is the solidity of the *sphere*.

Thus supposing the diameter of the *sphere* 56, the periphery will be found 175; which multiplied by the diameter, the product 9800 is the surface of the *sphere*; which multiplied by one sixth part of the diameter, gives the solidity 919057, or thus;

Find the cube of the diameter 175616; then to 300157, and the cube found, find a fourth proportional 919057. This is the soldity of the sphere required.

A gentleman was pleased to favour me with the following method, which he says he used for the mensuration of a globe, whose axis is 21 inches.

A GLOBE, *whose* axis *is* 21 *inches.*

21. *circumference.*
66
126
126
1386
$35\frac{1}{2}$ *of the axis.*
6930
4158
1728) 48510 (2 *feet*, 1395 *inch.*
3456
1395.

F. In.
4851 2. 1395
3456
1395

21
21
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42
441
21
441
882
9261
11
9261
9261
21) 101871 (1728
84
178
168
107
105
21
21
00

F. In.
1.75
1.75
875
1225
175
3.0625
1.75
153125
214375
30625
5.359375
5236
32156250
16078125
10718750
1393 26796875
806
2.8061687500
0507

9261 *cube of* 21
5236
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18522
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1728) 48490596 (2.1393
3456
1393

Before

Before we attempt to give the method of meaſuring a *cylinder*, we muſt remember, that a *cylinder* is a ſolid body contained under three ſurfaces; ſuppoſed to be generated by the rotation of a parallelogram, about one of its ſides.

If the generating parallelogram be rectangular, the *cylinder* introduced will be a right *cylinder*, i. e. a *cylinder*, whoſe axis is perpendicular to its baſe.

If the parallelogram be a *rhombus* or *rhomboides*, the *cylinder* will be *oblique* or *ſcabuous*.

The ſurface of a *right cylinder*, excluſive of its baſes, is demonſtrated to be equal to a rectangle contained under the periphery, and the altitude of the *cylinder*.

The periphery, therefore, of the baſe, and thence the baſe itſelf, being found, and multiplied by two, and the product added to the rectangle of the height, and periphery of the *cylinder*; the ſum will be the area or ſuperficies of the *cylinder*: Multiply this by the area of the baſe, and the product will be the ſolidity of the *cylinder*.

For it is demonſtrated, that a circle is equal to a triangle, whoſe baſe is equal to a periphery, and height to the radius; and alſo that a *cylinder* is equal to a triangular priſm, having the ſame baſe and altitude with itſelf; its ſolidity, therefore, muſt be had by multiplying the ſuperficies into the baſe.

Again, ſince a *cone* may be eſteemed an infinite angular pyramid; and a *cylinder* an infinite angular priſm; a *cone* is one third part of a *cylinder*, upon an equal baſe, and of the ſame height.

Further, a *cylinder* is to a ſphere of the ſame baſe and altitude, as 3 to 2.

Laſtly, it being demonſtrated in mechanicks, that every figure, whether ſuperficial or ſolid, generated either by the motion of a line, or of a figure, is equal to the factum of the generative magnitude into the way of its center of gravity, or the line its center of gravity deſcribes: Hence, if a rectangle revolves about its axis, it will deſcribe a *cylinder*, and its ſide the ſurface of the *cylinder*. But the center of gravity of the right line is in the middle; and the center of gravity of the generating plane in the middle of the right line. The way of this, therefore, is the periphery of a circle deſcribed by the radius, *i. e.* into the baſe: but the ſolidity of the *cylinder* is the factum of the generating rectangle, into the periphery of the circle deſcribed by the other radius, which is ſubduple of the ſemi-diameter of the *cylinder*.

Suppoſe, *v. gr.* the latitude of the deſcribing plane, and therefore of the *cylinder* B C $= a$, the ſemi-diameter of the baſe D C $= r$; then will E G $= \frac{1}{2} r$; and ſuppoſing the ratio of the ſemi-diameter to the periphery $= 1 : m$; the periphery deſcribed by the radius $\frac{1}{2} r$ will be equal to $\frac{1}{2} m r$. Therefore multiplying $\frac{1}{2} m r$ into the area of the rectangle A C $= a r$; the ſolidity of the *cylinder* $= \frac{1}{2} m a r$; but $\frac{1}{2} m a r 2 = \frac{1}{2} r m r a$, and $\frac{1}{2} r m r a$ and $\frac{1}{2} r m r$, the area of the circle deſcribed by the radius D G, the ſolidity of the *cylinder*, therefore, is equal to the factum of the baſe and the altitude.

To *determine the ſurface and ſolidity of a cube*. As the ſurface of a *cube* conſiſts of ſix equal ſquares, a ſide multiplied by itſelf, and the product by ſix, will give the ſuperficies; and the ſame product again multiplied by the ſide, the ſolidity.

Hence if the ſide of a *cube* be 10, the ſolidity will be 1000; if that be 12, this will be 1728: wherefore the geometrical perch being 10 foot, and the geometrical foot 10 digits, *&c.* the *cubick* perch is 1000 *cubick feet*, and a *cubick* foot is 1000 *cubick* digits, *&c.*

Hence alſo *cubes* are in a triplicate ratio of their ſides, and are equal if their ſides be ſo.

To *meaſure the ſolidity of a cone*. Find the ſolidity of a priſm or cylinder, having the ſame baſe with the cone; which found, divided by three, the quotient will be the ſolidity of a cone. Thus, *v. gr.* if the ſolidity of a cylinder be 605592960, the ſolidity of the cone will be found 201864320.

As to the *meaſure of the ſolidity of a truncated cone*: As the difference of the ſemi-diameter is to the altitude of the truncated cone, ſo is the greater ſemi-diameter to the altitude of the entire cone. This found, ſubſtract the altitude of the truncated cone, which will leave that of the cone taken off. Find the ſolidity of the two cones, ſubſtract one from the other; the remainder will be the ſolidity of the truncated cone.

To find the ſolidity of a hollow body.—If the body be compriſed in the number of regular bodies, the ſolidity firſt of the whole body, including the cavity, then that of the cavity, which is ſuppoſed to have the ſame figure with the body itſelf, is to be found; and the latter being ſubſtracted from the former, the remainder is the ſolidity of the hollow body required.

As to the *meaſuring of* TIMBER.—*Timber* is uſually meaſured and eſtimated by the load or ton, which is a ſolid meaſure containing 40 feet of round *timber*, or 50 of hewn *timber*. The denomination of load, *&c.* we ſuppoſe ariſes from hence, that 40 or 50 ſolid feet of ſuch *timber* weighs about a ton, *i. e.* twenty hundred weight, which is uſually accounted a cart load.

1. For the *meaſuring of round timber*: The practice is, to gird the tree about in the middle of the length, and folding the line twice, to take one length or quarter of the whole, and account that

for the true side of the square: then for the length, it is counted from the but-end of the tree, so far up as the tree will hold *half a foot girt*, as they call it, *i. e.* so long as the line twice folded is half a foot.

The dimensions thus taken, the quantity of *timber* is had, either by multiplying the side of the square into itself, and that product by the length, by the method of cross-multiplication.

Or more easily and speedily on Gunter's line, by extending the compasses from 12 to the side of the square in inches; for that extent turned twice (the same way) from the length in feet, will reach to the content in feet.

Or the better still, on *Coggeshal*'s sliding-rule, by setting 12 on the girt-line D, to the length in feet on the line C; then against the side of the square, on the girt-line D, taken in inches, you have on the line C the content of the *timber* in feet.

This method of measuring round timber, tho' common, is yet erroneous, and the contents found hereby, it is demonstrated, is less than the true contents or measure in the ratio of 11 to 14. How to avoid this error, and measure it justly, I have shewn under the use of *Coggeshal*'s sliding-rule.

If the tree have any great boughs that are *timber*, as the phrase is, *i. e.* which will hold feet girt, they are commonly measured, and added to the rest; the solidity of the whole being thus found, they divide it by 40, which brings it into loads.

In measuring round timber for sale, they usually cast away an inch out of the square for the bark, if oak; so that a tree 10 inches square, they only account as if 9; but for ash, elm, beech, *&c.* an inch is too much.

For the measuring hewn or square timber; the practice is to find the middle of the length of the tree, and there to measure its breadth, by clapping two rules, or other strait things to the sides of the tree, and measuring the distance between them: in the like manner they measure the breadth the other way. If the two be found unequal, they add them together, and take half the sum for the true side of the square.

The dimensions thus taken, the content is found either by cross-multiplication, Gunter's scale, or the sliding-rule, after the manner already directed.

The contents divided by 50, gives the number of loads.

If the *timber* be unequally sided, this method of measuring is erroneous, always giving the content more than the truth, and the more so, as the difference of the sides is greater; yet custom has authorised it.

To measure such *timber* justly, a mean proportion should be found between the unequal sides and this mean be accounted the side of the square.

STOCKING-MAKING.

STOCKING-MAKING is the forming a kind of cloathing of the leg and foot, which immediately covers their nudity, and skreens them from the rigour of the cold.

Stockings are either knit or wove.

Knit Stockings are wrought with needles made of polished iron or brass wire. There must be five of them, four to hold the mashes the *stocking* consists of, and one to work with.

The first process in knitting *stockings*, whether they be of silk, wool, cotton, thread, *&c.* is to twist loosely three threads together, the *stockings* made of two threads only being very slight, and of very little service. Then you form on each of the four needles a certain number of mashes, greater or less, according to the size the *stocking* must be of; observing that there must be an equal number of mashes on each needle; which number is to be diminished or increased in the process of the work, according as the shape of the *stocking* requires it. To diminish the number, they work two or three mashes together at once.

The invention of this operation it were difficult to fix precisely, though it is commonly attributed to the *Scots*.

The islands of *Jersey* and *Guernsey* are famous for this sort of work; and it is almost their sole commerce, and the sole occupation of the female inhabitants, who are so much used to it from their infancy, that they work with an incredible quickness, whether they be sitting or walking, and whether in the dark or in the light; for they seldom look on their work. They also knit breeches, waistcoats, petticoats, and the like.

Woven stockings are ordinarly very fine; they are manufactured on a frame or machine made of polished iron; the structure whereof is exceedingly ingenious, but withal exceeding complex, so that

it

it were very difficult to deſcribe it well, by reaſon of the diverſity and number of its parts; nor is it even conceived, without a deal of difficulty, when working before the face.

The *Engliſh* and *French* have greatly conteſted the honour of the invention of the *ſtocking-loom*; but the matter of fact (ſays an *Engliſh* author) waving all national prejudices, ſeems to be this: that it was a *Frenchman* firſt invented this uſeful and ſurpriſing machine, who finding ſome difficulties in procuring an excluſive privilege, which he required to ſettle himſelf at *Paris*, went over into *England*, where his machine was admired, and the workman rewarded according to his merit.

SUGAR-REFINING.

SUGAR-REFINING is the art of purifying it of all its coarſer particles, and render it drier, more compact, more agreeable to the palate, and more beautiful.

The firſt preparation the ſugar-canes undergo after they are cut, and their leaves cleared off, is to be carried in bundles to the mills; which mills conſiſt of three wooden rollers, covered with ſteel plates, and have their motion either from the water, the wind, cattle, or even the hands of ſlaves.

The juice coming out of the canes when preſſed and broke between the rollers, runs through a little canal into the ſugar-houſe, which is near the mill, where it falls into a veſſel, whence it is conveyed into a copper or cauldron, to receive its firſt preparation, only heated by a ſlow fire to make it ſimmer. With the liquor is here mixed a quantity of aſhes and quick-lime; the effect of which mixture, aſſiſted by the action of the fire, is, that the unctious parts are ſeparated from the reſt, and raiſed to the top, in form of a thick ſcum, which is kept conſtantly ſkimming off, and ſerves to feed the poultry, *&c.* withal.

The juice, in the next place, is purified in a ſecond copper, where a briſker fire makes it boil; and all the time the caſting up of its ſcum is promoted by means of a ſtrong lye, compoſed of lime-water and other ingredients.

This done, it is purified and ſkimm'd in a third boiler, wherein is caſt a kind of lye, that aſſiſts in purging it, collects together its impurities, and makes them riſe to the ſurface, whence they are taken with a ſkimmer.

From the third it is removed to a fourth boiler, where the juice is farther purified by a more violent fire: and hence to a fifth, where it is brought to the conſiſtence of a ſyrup.

In the ſixth boiler the ſyrup receives its full coction; and here all the impurities left from the former lyes, are taken away by a new lye, and a water of lime and aſſum caſt into it. In this laſt copper there is ſcarce found one third of what was in the firſt, the reſt being waſted in ſcum.

By thus paſſing ſucceſſively a number of coppers, the ſugar-juice is purified, thickened, and rendered fit to be converted into any of the kinds of *ſugar* hereafter mentioned. The ſize of the ſeveral coppers always diminiſhes from the firſt to the laſt; each being furniſhed with a furnace to give a heat proportionable to the degree of coction the juice has received. In ſome large ſugar-works there are alſo particular coppers for the boiling and preparing the ſcum.

F. *Labat* mentions ſeveral kinds of *ſugars*, prepared in the *Caribbee Iſlands*, viz. *crude ſugar*, or *muſcovado*; *ſtrained*, or *brown ſugar*; *earthen*, or *white ſugar* in powder; *refined ſugar*, either in powder or loaves; *royal ſugar*, *candied ſugar*, *ſugar of fine ſyrup*, *ſugar of coarſe ſyrup*, *ſugar of the ſcum*.

Crude ſugar, or *muſcovado*, is that firſt drawn from the juice of the cane, and whereof all the reſt are compoſed. The method of making it, is that already deſcribed for *ſugar* in general. We need only add, that when taken out of the ſixth copper, it is put in a cooler, where ſtirring it briſkly together, it is let ſtand to ſettle, till a cruſt of the thickneſs of a crown-piece be formed thereon. The cruſt being formed, they ſtir it up again, then put it into veſſels, where it ſtands to ſettle till it be fit to barrel.

Strained or *brown ſugar*, though whiter and harder, does not differ much from the crude ſugar: tho' it is held a medium between this laſt, and the earthen ſugar, which is the white powder *ſugar*. The preparation of this is the ſame of that of the muſcovado, with this difference, that to whiten it they ſtrain the liquor through blankets, as it comes out of the firſt copper. The invention of *ſtrained ſugar* is owing to the *Engliſh*, who are more careful than their neighbours in the preparation thereof; for they not only ſtrain it, but when boiled put it in ſquare wooden forms or moulds, of a pyramidal figure; and when it has purified itſelf well, they cut it in pieces, dry it in the ſun, and barrel it up.

As to the preparation of *earthen ſugar* (which is that *ſugar* whitened by means of earth laid on the top of the form it is put in, to purge itſelf) they begin it after the ſame manner as that of crude *ſugar*, except that they only uſe the beſt that comes in it; that they work with more care and nicety; that when the liquor is in the firſt copper, the aſhes they put in are little or nothing mixed with lime, for fear of reddening it; and that they ſtrain it through a blanket, from the firſt to the ſecond copper.

Having paſſed all the ſix coppers, it is laden out into a cooler; whence it is put into conical moulds or forms, the tops whereof are perforated, but now ſtopped with linen, or other ſtuff; and this ranged even before the furnace. When it has been a quarter of an hour in the forms, it is cut with a ſugar-knife, then it is ſtirred briſkly this way and that, for half an hour.

This ſerves not only to promote the forming of the grain, and the diffuſing it equally throughout; but alſo to determine the unctuous parts of the *ſugar* to mount to the top, that they may be ſkimmed off.

They leave the forms to ſtand fifteen hours in this ſtate, and unſtop the holes at the bottom to give a paſſage to the ſyrup, and to determine it to take that way. When enough of theſe forms are filled, to fill a ſtove, which uſually contains five or ſix hundred forms; they viſit the ſugar in all the forms to examine the quality thereof, and to ſee if it quits the form eaſily; that it may either have the earth given it, as the refiner who aſſiſts it judges proper; or be melted over again, if it does not prove well.

This done, the forms are planted each on its pot, with the tip of the cone downwards; the top is taken off, and in lieu thereof they put in ſome *ſugar* in grain, to within an inch of the edge; which ſpace is left for the earth prepared for it.

The earths here uſed are of various kinds, the good qualities of each whereof are, that they do not tinge the water, that they let it filtrate eaſily through, and that they do not imbibe the fatty part of the *ſugar*. Before put in the forms, the earth is ſteeped in water twenty-four hours; and at length applied in the conſiſtence of a pulp.

As ſoon as the earth is on the *ſugar*, all the windows of the refining-room are ſhut, that the air and heat may not dry the earth. When it is quite dry, which uſually happens in nine or ten days time, it is taken off; and after cleaning the ſurface of the ſugar with bruſhes, and racking it up an inch deep, and laying it level as before, they give it a ſecond earth.

The whiteneſs of the *ſugar* of each form is ſeen from the firſt earth, experience ſhewing that a ſecond or third earth do not make the *ſugar* any whiter, but only whitens the head of the loaf. When the ſecond earth is taken off, they clean the ſurface of the *ſugar* with a bruſh, and with a knife looſen the edge of it, where it ſticks to the form, that neither form nor the ſugar-loaf be damaged in taking out the latter. The windows are now opened, and the form left to ſtand eight or ten days to dry. While the *ſugar* is draining in its forms a ſtove is prepared to receive them.

The ſtove being ſufficiently heated by means of the furnace therein; the loaves are taken out of the forms one after another; and ſuch as are white from one end to the other, are carried to the ſtove, as are alſo the reſt, after cutting off what is not white, to be further refined.

When the loaves are all ranged in the ſtove, a moderate fire is made for about two days, during which time they viſit every part of the ſtove very carefully, to ſee that every thing is in good order, and to repair every thing that may go amiſs. After theſe two days they ſhut the trap-door a-top of the building, and increaſe the fire. Eight or ten days and nights continued violent fire uſually ſuffice to dry a ſtove of ſugar.

When they judge it ſufficiently done, they open the trap-door, and chuſe a hot dry day to pound the ſugar, which is performed with huge, hard, heavy wooden peſtles; when pounded it is put up in barrels, and well trodden down as it is put in, that the barrels may hold the more.

Sugar of the ſcum, is all made of the ſcum of the two laſt coppers; that of the former being reſerved for making of rum.

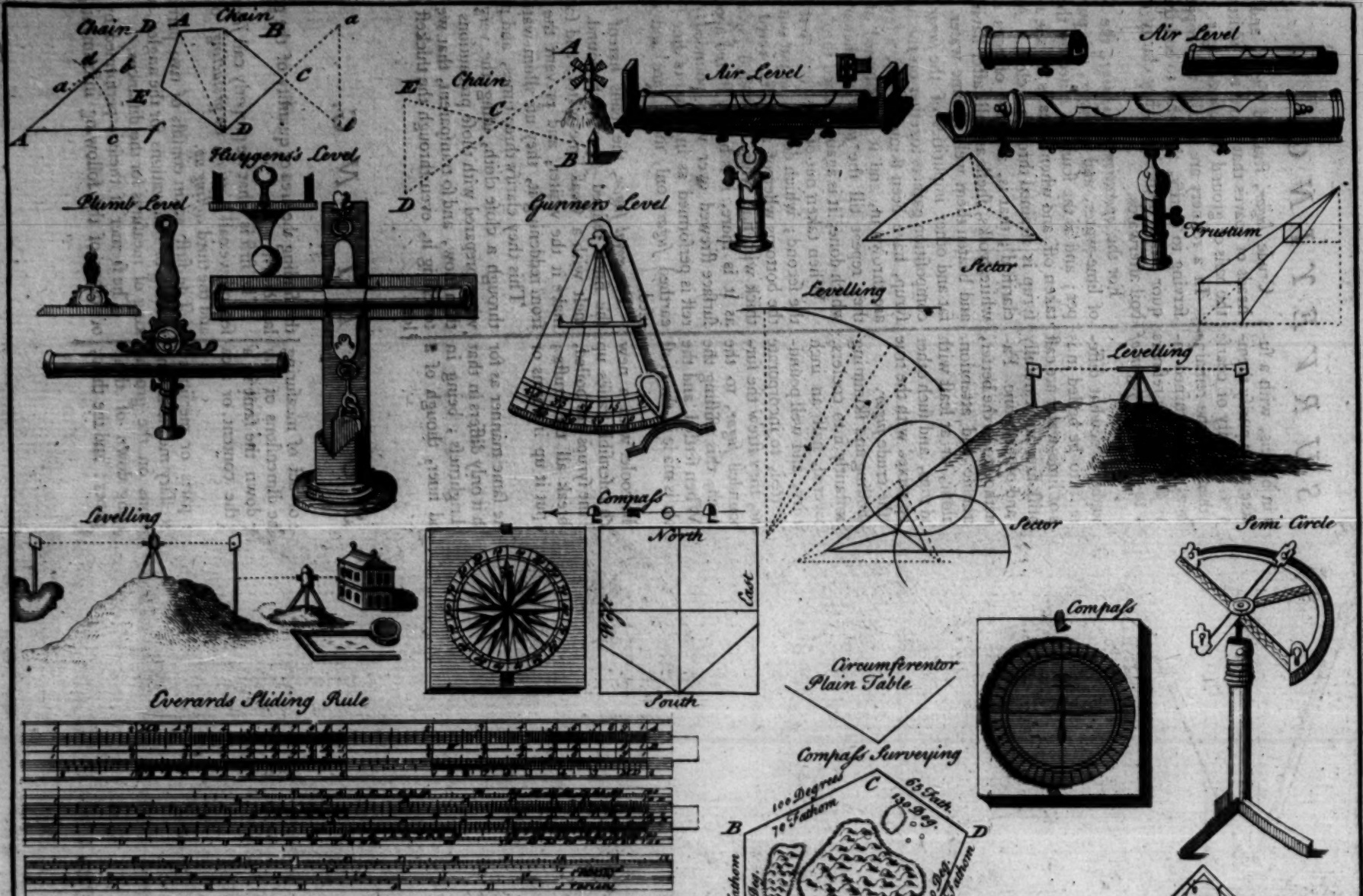
The ſcum deſigned to make *ſugar* is kept in a veſſel for that purpoſe, and boiled every morning in a copper ſet apart for that uſe. With the ſcum is put into the copper a fourth part of water, to retard the boiling, and give time for its purging; when it begins to boil, the uſual lye is put in, and it is carefully ſkimmed: when almoſt enough boiled, lime and allum-water are thrown in. And when it is ready to be taken out, they ſprinkle it with a little powder'd allum.

There are three kinds of ſyrup that run from *ſugar*. The firſt from the barrels of raw *ſugar*, which is the coarſeſt of all: the ſecond from the forms or moulds, after they are perforated, and before they receive their earth: the third, that coming from the forms after they have had their earth, which laſt is the beſt.

The coarſe ſyrups ſhould only be uſed for rum; but *ſugar* being grown dear, endeavours have been uſed to make ſome hereof, and that with tolerable ſucceſs. They are firſt clarified with lime-water,

and

SURVEYING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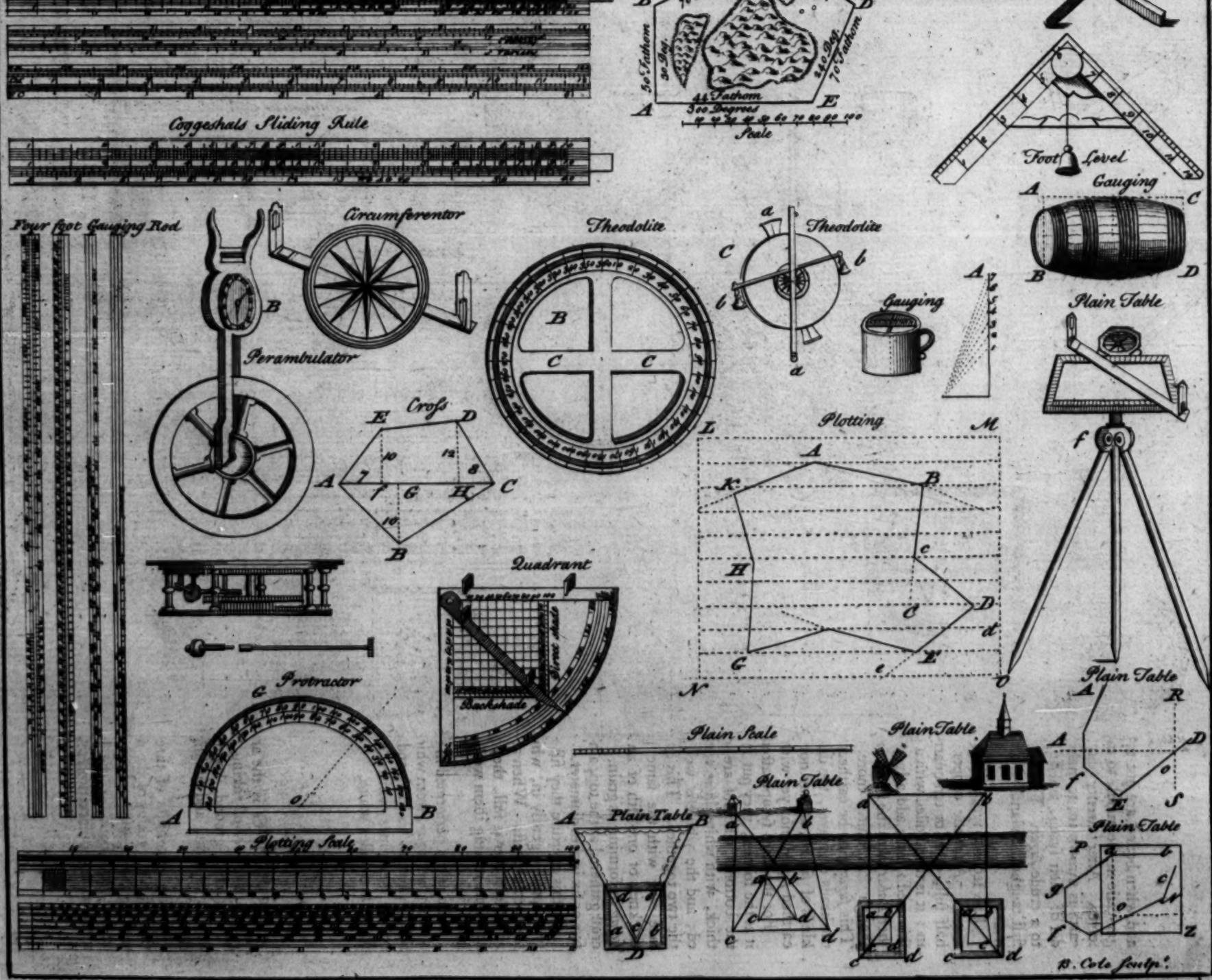
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Plain Scale
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Plotting Scale
B. Cole Sculpt.

and when boiled are put up in barrels, with a ſugar-cane in the middle to make them purify themſelves. After twenty days a quantity of coarſe earth is thrown in, to make them caſt the remainder of their ſyrup, and fit them to be returned into a crude *ſugar*. The *Dutch* and *German* refiners firſt taught the iſlanders how to make this *ſugar of treacle*.

The ſecond ſyrup is wrought ſomewhat differently. After the copper it is to be boiled in is half full, eight or ten quarts of lime-water are caſt in: it is then boiled with a briſk fire, and carefully ſkimmed: ſome add a lye, and others none. Father *Labat* takes the former method to be the better, though it requires more trouble and attention. This *ſugar* may be earthed alone, or at leaſt with the heads of loaves, the dried tops, and ſuch other kinds of *ſugars*, as may not be mixed with the true earthed *ſugar*, nor yet with the crude *ſugar*.

For the third ſyrup, after boiling and ſkimming it as the former, they put it inſtantly into coolers, the bottoms whereof are covered, half an inch thick, with white *ſugar* very dry, and well pounded; and the whole is well ſtirred, to incorporate the two together. This done, they ſtrew the ſurface over with the ſame pounded *ſugar*, to the thickneſs of one fifth of an inch, this aſſiſting the *ſugar* in forming its grain. When ſettled, and the cruſt gathered at the top, a hole is made in the cruſt five or ſix inches diameter.

By this aperture they fill the cooler with a new ſyrup poured gently in, which inſenſibly raiſes up the former cruſt. When all the ſyrups are boiled, and the cooler is full, they break all the cruſts; and after mixing them well, put it up in forms or moulds.

The reſt is performed in the ſame manner as for the earthed *ſugar*, from which it only differs in that it falls ſhort of its gloſs and brightneſs; being in reality ſometimes whiter and finer, though of a flatter and duller white.

Crude *ſugar*, ſtrained *ſugar*, and the tops or heads of loaves that have not whitened well, are the baſis or ground of refined ſugar.

In a refinery are uſually two coppers, the one ſerving to clarify, the other to boil the clarified liquor; tho' ſometimes they clarify in both, and boil afterwards.

For the *operation of refining*, the ſame weight of lime-water, and of *ſugar*, are put in the copper; and as the ſcum is raiſed by the heat, it is taken off, and when it ceaſes to raiſe any more, the ſyrup is ſtrained through a cloth. After this it is clarified; that is, a dozen of eggs is thrown in, white, yolks, ſhells and all, after having firſt broke and beaten them well in lime-water. When the fat and other impurities of the *ſugar*, which this compoſition gathers together on the ſurface of the ſyrup, have been ſkimmed off, a few more eggs are thrown in, and it is ſkimmed afreſh. This they repeat till the *ſugar* is ſufficiently clarified; which done, it is again ſtrained thro' the cloth.

When taken out of this copper, it is boiled in the ſecond; which done, it is put out into coolers, the bottoms whereof are firſt covered half an inch thick with fine white powdered *ſugar*. As ſoon as it is there, it is briſkly ſtirred about, and the ſurface ſtrewed over with pounded *ſugar*. The reſt is performed as in *ſugars* of fine ſyrups, or in earthed *ſugar*, only more care and exactneſs is uſed.

For *royal ſugar*, the baſis hereof ought to be the fineſt refined *ſugar* to be found. This they melt with a weak lime-water, and ſometimes, to make it the whiter, and prevent the lime-water from reddening it, they uſe allum-water.

This they clarify three times, and paſs as often through a cloſe cloth, uſing the very beſt earth: when prepared with thoſe precautions it is whiter than ſnow, and ſo tranſparent, that we ſee a finger touching it, even through the thickeſt part of the loaf.

SURVEYING.

SURVEYING is the art or act of meaſuring lands, *i. e.* of taking the dimenſions of any tract of ground, laying down the ſame in a map or draught, and finding the content or area thereof.

Surveying conſiſts of three parts or meaſures: the firſt is the taking of the neceſſary meaſures, and making the neceſſary obſervations on the ground itſelf: the ſecond, is the laying down of theſe meaſures and obſervations on paper; and the third, the finding the area or quantity of the ground thus laid down.

The firſt is what we properly call *ſurveying*; the ſecond we call *plotting*, or *protacting*, or *inapping*; and the third *caſting up*.

The firſt again conſiſts of two parts, *viz.* the making of obſervations for the angles, and the taking of meaſures for the diſtances.

The former of theſe is performed by ſome one or other of the following inſtruments, *viz.* the *theodolite*,

theodolite, circumferentor, ſemi-circle, plain table, or *compaſs*.

The THEODOLITE is a mathematical inſtrument made variouſly; ſeveral perſons having their ſeveral ways of contriving it, each more ſimple and portable, more accurate and expeditious than others. The following one is not inferior to any. It conſiſts of a braſs circle, about a foot diameter, cut in form of *fig.* 25. having its limb divided into 360 degrees, and each degree divided, either diagonally or otherwiſe into minutes.

Underneath, at *c c*, are fixed two little pillars, *b b*, *fig.* 25. *N.* 2. which ſupport an axis, whereon is fixed a teleſcope, conſiſting of two glaſſes, in a ſquare braſs tube, for the viewing of remote objects.

On the center of the circle, moves the index C, which is a circular plate, having a compaſs in the middle, whoſe meridian anſwers to the fiducial line *a a*: at *b b*, are fixed two pillars to ſupport an axis, which bears a teleſcope like the former, whoſe line of collimation anſwers the fiducial line *a a*. At each end of either teleſcope is fixed a plain ſight for the viewing nearer objects.

The ends of the index *a a*, are cut circularly to fit the diviſions of the limb B; and when that limb is diagonally divided, the fiducical line at one end of the index ſhews the degrees and minutes upon the limb. The whole inſtrument is mounted with a ball and a ſocket, upon a three-legged ſtaff.

Moſt *theodolites* have no teleſcopes, but only four plain ſights, two of them faſtened on the limb, and two on the ends of the index.

The SEMICIRCLE, called alſo *graphometer*, conſiſts of a ſemicircular limb, as F I G, fig. 16. divided into 180 degrees, and ſometimes ſubdivided diagonally, or otherwiſe, into minutes. This limb is ſubtended by a diameter F G, at the extremities whereof are erected two ſights. In the center of the *ſemicircle*, or the middle of the diameter, is fixed a box, and on the ſame center is fitted an alidade or moveable index, carrying two other ſights, as H I. The whole is mounted on a ſtaff, with a ball and ſocket.

The *ſemicircle*, then, is nothing elſe but half a theodolite, with this only difference; that whereas the limb of the theodolite, being an entire circle, takes in all the 360° ſucceſſively; in the *ſemicircle*, the degrees only going from 1 to 180°, it is uſual to have the remaining 180°, or thoſe from 180° to 360°, graduated in another line on the limb, within the former.

An angle is taken with a ſemicircle, by placing the inſtrument in ſuch manner, as that the radius C G, may hang over one leg of the angle to be meaſured, and the center C, over the vertex of the ſame. The firſt is done by looking through the ſights F and G, at the extremities of the diameter, to a mark fixed up in one extremity of the leg: the latter is had by letting fall a plummet from the center of the inſtrument. This done, turn the moveable index H I, on its center, towards the other leg of the *ſemicircle*, till, through the ſights fixed on it, you ſee a mark in the extremity of the leg. Then the degree, which the index cuts on the limb, is the quantity of the angle.

The plain table is an inſtrument, fig. 31. N. 1. conſiſting of a parallelogram of wood, about fifteen inches long, and twelve broad; round which goes a boxen jointed frame, by means whereof a ſheet of paper is faſtened tight to the table, ſo as lines may be conveniently drawn upon it.

On each ſide the frame, which may be put on either ſide upwards, towards the inward edge are ſcales of inches, ſubdivided, for the ready drawing of parallel lines. Beſides which, on one ſide are projected the 360 degrees of a circle, from a braſs centre in the middle of the table (each degree halved) with two numbers to every tenth degree, the one expreſſing the degree, the other its complement to 36°, to ſave ſubſtraction on the other ſide, are projected the 180° of a ſemicircle, from a braſs center in the middle of the table's length, and at $\frac{1}{4}$ of its breadth; each degree halved, and every tenth noted with two numbers, *viz.* the degree, and its complement to 180°.

To one ſide of the table is fitted a compaſs, for placing the inſtrument by; and the whole is fixed by a ſocket, upon a three-legg'd ſtaff for a ſtand, on which it is turned round, or faſtened by a ſcrew, as occaſion requires. Laſtly, to the table belongs an index, which is a ruler, at leaſt ſixteen inches long, and two broad; uſually graduated with ſcales, *&c.* and having two ſights perpendicularly placed on its extremities.

We underſtand here by ſights two thin pieces of braſs, raiſed perpendicularly on the two extremes of an alidade, or index of a theodolite, circumferentor, or other like inſtrument, each whereof has an aperture or ſlit up the middle, through which the viſual rays paſs to the eye, and diſtant objects are ſeen. Their uſe is for the juſt direction of the index to the line of the object. Sometimes the ſlits or apertures have glaſſes or lens's fitted into them; in which caſe they are called *teleſcopick ſights*, by way of diſtinction from the former, which in reſpect hereof are denominated *plain ſights*.

Staff, in ſurveying, is a kind of ſtand, whereon to mount a theodolite, circumferentor, plain

plain table, or the like, for uſe. It conſiſts of three legs of wood joined together at one end, whereon the inſtrument is placed: and made peeked at the other, to enter the ground. Its upper end is uſually fitted with a ball and ſocket.

Ball and ſocket, is a machine, contrived to give an inſtrument full play and motion every way. It conſiſts of a ball or ſphere of braſs, fitted within a concave ſemi-globe, ſo as to be moveable every way, both horizontally, vertically, and obliquely. It is carried by an endleſs ſcrew, and is principally uſed for the managing of ſurveying inſtruments; to which it is a very neceſſary appendage. The antient *balls and ſockets*, had two concaves or channels, the one for the horizontal, the other for the vertical direction. But to proceed to *the uſe of the plain tables*, after we have given the deſcription thereof.

To take an angle by the *plain table*, or to find the diſtance of two places acceſſible by the ſame third.—Suppoſing D A, D B, fig. 32, N. 2. the ſides of the angle required; we'll place the inſtrument horizontally, as near the angle as poſſible; and aſſume a point in the paper on the table, *v. gr.* to this point we'll apply the edge of the index, turning it about this and that way, till through the ſights we ſee the point B, and in this ſituation of the ruler, we'll draw by its edge the line *c e*, indefinitely. Turning about the index, after the ſame manner, on the ſame point, till through the lights we ſee the point A; and drawing the right line *c d* indefinitely.—Thus we have the quantity of the angle laid down.

We'll next meaſure the lines D A, D B, with a chain, and from a ſcale ſet off the meaſures thus found, on the reſpective lines; which we ſuppoſe to reach from *c* to *b*, and from *c* to *a*.—Thus will *c b* and *c a* be proportional to D B and D A.

We'll transfer the diſtance *a b* to the ſame ſcale, and find its length; the length thus found, will be the length or diſtance of A B required.

If we want to *find the diſtance of two places, one whereof is inacceſſible*, by the plain table: we'll ſuppoſe A B, fig. 33. the diſtance required, and A the acceſſible point. Then we'll place, 1. the *plain table* in C, looking through the ſights till we ſee A and B, and drawing *a c* and *c b*, we'll meaſure the diſtance from our ſtation to A; and ſet it off from the ſcale upon *c a*. 2. We'll remove the table to A, placing it ſo as that the point *a* repreſenting A, and the index laid along the line *a c*, we'll ſee backward the former ſtation C.

In this fixing the inſtrument, lies the uſe of the compaſs; for the needle will hang over the ſame degree of the card in the firſt and the ſecond caſe; ſo that ſome ſet the inſtrument by the needle alone; others only uſe it to ſhorten the trouble, by bringing the inſtrument nearly to its due poſition by means thereof; and then fixing for good by the back ſight.

3. The inſtrument fixed, we'll turn the ſights to B; and draw the line *a b*.

4. On the ſcale we'll meaſure the interval *a b*; which will be the diſtance of A B required.

But if we ſhould want *to find the diſtance of two inacceſſible places by the plain table*; we would ſuppoſe A B, fig. 34, the diſtance required. Then chuſing, 1. two ſtations in C and D; we would place the *plain table* in the firſt C, and through the ſights look to D, B, and A, drawing by the edge of the index, the lines *c d*, *c b*, *c a*. We would, 2. meaſure the diſtance of the ſtations C D; and ſet this off from a ſcale on *c d*. 3. Removing the *table* from C, we would fix it in D; ſo as the point *d*, hanging over the place D, and the index laying along the line *c d*, through the ſights we ſhould ſee the former ſtation C. The inſtrument thus fixed, we would direct the ſights to A and B; and drawing right lines *d a* and *d b*. Laſtly, we would find the diſtance of *a b* on the ſcale; this would be the diſtance of A B required.

After the ſame manner may the diſtance of any number of places be found from two ſtations; and thus may a field, part of a country, *&c.* be ſurveyed.

To *take the plot of a field from one ſtation, whence all the angles may be ſeen, with the plain table.*—Placing the inſtrument on the ſtation, aſſume a point in the paper to repreſent the ſame, *v. gr.* C, fig. 21. laying the edge of the index to this point, direct it to the ſeveral angles of the field, A B C D E F, *&c.* and drawing indefinite lines by its edge, towards every angle, *viz.* C *a*, C *b*, C *c*, *&c.* meaſure the diſtance of each angle from the ſtation, *viz.* C A, C B, C C, C D, *&c.* and from a ſcale ſet theſe off from C on their correſponding lines; the extremities thereof will give points, which being connected by lines, will repreſent the field.

The *plot of a field, wood, or the like, is taken by going round the ſame, on the plain table*, by placing the inſtrument horizontally at the firſt angle, *v. gr.* A, the needle on the meridian of the card; aſſuming a point on the paper to repreſent it; laying the index to that point, and directing it till through the ſights you ſee a mark in the angle B, and

drawing an indefinite line along it; measure the distance of A and B, and from a scale set it off on the line thus drawn; the extremity of this distance will represent the point B. Remove the instrument to B, where set it so as that the needle hang over the meridian of the cord; and so as the index laying along the line last drawn, you see the former station A through the sights: here fasten it, lay the index to the point B, and turn it, till through the sights you see the next angle C; in this situation draw a line as before, measure the distance B C, and set it off from a scale on the line. Remove the instrument to C, where fixing it by the needle, and the back sight, as before, turn the index on the point C, till you see the next angle D; draw the line, measure, and set off the distance C D, as before, and remove the *plain table* to E; where fix it as before, look to the next angle F, draw the line, measure, and set off the distance, *&c.*

In this manner having compassed the whole field, you will have its whole perimeter plotted on the table; which may be now cast up, and its contents found.

When in large parcels of ground, the plot is found to exceed the dimensions of the *plain table*, and to run off from the paper, the sheet must be taken off the table, and a fresh one put on; the way of managing which shifting is as follows. Suppose H, K, M, Z, fig. 35. the limits of the *plain table*; so that having laid down the field from A to B, thence to C and D, you want room, the line D E running off the paper: draw as much of the line D E, as the paper will well hold, *viz.* D O, and by means of the divisions on the edge of the frame, draw the line P Q through G, parallel to the edge of the table H M; and through the point of intersection O, draw O N parallel to M Z. This done, take off the frame, remove the sheet, and clap a fresh one, fig. 36. in its stead; drawing on it a line R S, near the other edge parallel thereto. Then lay the first sheet on the table, so as the line P Q lie exactly on the line R S, to the best advantage, as at O. Lastly, draw as much of the line O D, on the fresh sheet, as the table will hold; and from O continue the remainder of the line D to E; from E proceed with the walk as before, to F, G, and A.

The great inconvenience of the plain table is, that its paper renders it impracticable in moist weather. Even the dew of the morning and evening is found to swell the paper considerably, and of consequence to stretch and distort the work. To avoid this inconvenience, and render the instrument useful in all weathers; by leaving off the paper, and setting up a pin in the center, it becomes a theodolite, a semicircle, or a circumferentor, and applicable like them.

The *plain table* stripped of its paper, becomes either a theodolite, or a semicircle, as that side of of the frame which has the projection of the degrees of a circle, or a semicircle is turned upwards. If it be to serve for a theodolite; the index, which as a *plain table*, turns on any point as a center, is constantly to turn about the brass center hole, in the middle of the table.

If for a semicircle, it must turn on the other brass center hole: in both cases it is done by means of a pin raised in the holes.

When the *plain table* is to serve as a circumferentor, screw the compass to the index, and both of them to the head of the staff, with a brass screw pin fitted for the purpose; so as the staff and table standing fixed, the index, sights, *&c.* may be turn'd about, and *vice versâ*.

To *take an angle by the plain table considered as a theodolite.*—Suppose the quantity of the angle E K G, fig. 20. is required. Place the instrument, or K, the theodolite side of the frame upwards, laying the index on the diameter. Turn the whole instrument about, the index remaining on the diameter, till through the sights you spy E. Screw the instrument fast there, and run the index on its center, till through the sight you spy G. The degree here cut on the frame by the index, is the quantity of the angle sought; which may be laid down on paper by the rules of common protraction.

Thus may you proceed to do every thing with the *plain table*, as with the common theodolite.

If we want to make an angle with a plain table considered as a semicircle. We must proceed in the same manner with the instrument, consider'd as a semicircle, as when consider'd as a theodolite; only laying the semicircular side upwards, and turning the index on the other center-hole in the middle of the length, and at about $\frac{1}{4}$ of the breadth of the table.

If you want to take an angle with the plain table considered as a circumferentor. Suppose the former angle E K G, required. Place the instrument in K, the flower-de-luce towards you. Direct the sights to E, and observe the degree cut by the south end of the needle, which suppose 296, turn the instrument about, the flower-de-luce still towards you. Direct the sights to G, noting the degree cut by the other end of the needle, which suppose 182. Substract the less from the greater, the remainder 114° is the quantity of the angle sought. If the remainder chance to be more than 180°, then it must be again substracted from 360. This se-

cond

cond remainder will be the angle required; which may be protracted, *&c.*

Thus you may proceed to do every thing with the plain table, as with the common *circumferentor*.

The CIRCUMFERENTOR, is an inſtrument uſed in *ſurveying*, to take angles by.

The *circumferentor* is very ſimple, yet expeditious in the practice; it conſiſts of a braſs circle, and an index, all of a piece (fig. 19.) On the circle is a card or compaſs divided into 360 degrees; the meridian lines whereof anſwers to the middle of the breadth of the index. On the limb, or circumference of the circle, is ſoldered a braſs ring; which, with another fitted in a glaſs, make a kind of box for the needle, which is ſuſpended on a pivot in the center of the circle. To each extreme of the index is fitted a ſight.

The whole is mounted on a ſtaff, with a ball and ſocket for the conveniency of its motion.

If we want to take an angle by the circumferentor. Suppoſe E K G (fig. 20.) the angle required, we'll place the inſtrument, *v. gr.* at K, with the flower-de-luce on the card towards us; then direct the ſights, till thro' them we ſpy E; and obſerve what degree is pointed at by the ſouth end of the needle, which ſuppoſe 296, then turn the inſtrument, the flower-de-luce ſtill towards us, and direct the ſights to G; noting the degree at which the ſouth end of the needle points, which ſuppoſe 182.

This done, ſubſtracting the leſſer number 182, from the greater 296, the remainder 114, is the number of degrees of the angle E K G.

If the remainder chance to be more than 180 degrees, it muſt be again ſubſtracted from 360 degrees; the laſt remainder is the quantity of the angle ſought.

To take the plot of a field, wood, &c. by the circumferentor; ſuppoſe ABCDEFGK (fig. 21.) an incloſure to be ſurveyed by the *circumferentor*.

1. Placing the inſtrument at A, the flower-de luce towards you, direct the ſights to B; where ſuppoſe the ſouth end of the needle to cut 191°; and the ditch, wall, or hedge, meaſured with the chain, to contain 10 chains, 75 links, which enter down.

2. Placing the inſtrument at B, direct the ſight as before to C; the ſouth end of the needle, *v. gr.* will cut 279°; and the line B C contains ſix chains, 83 links, to be noted as before. Then move the inſtrument to C; turn the ſights to D, and meaſure C D as before.

In the ſame manner proceed to D, E, F, G, H, and laſtly to K; ſtill noting down the degrees of every bearing or angle, and the diſtances of every ſide.

Having thus gone round the field, you will have a table in the following form:

Stations.	*Degrees.*	*Min.*	*Chains.*	*Links.*
A	191	00	10	75
B	279	00	6	83
C	216	30	7	82.

From this table the field is to be plotted or protracted; the manner whereof we'll ſee hereafter.

Note, That where ſecurity is to be conſulted rather than diſpatch, it may be convenient to take back-ſights, *i. e.* to place the inſtrument ſo at each ſtation, as that looking backwards through the ſights to the laſt ſtation, the north end of the needle may point to the ſame degree, as the ſouth end did in looking forward from the laſt ſtation to this.

The COMPASS uſed in *ſurveying*, is in the main much like the mariner's *compaſs*; conſiſting, like that of a box and needle: the principal difference conſiſt in this, that inſtead of the needle being fitted into the card, and playing with it on a pivot, it here plays alone; the card being drawn on the bottom of the box, and a circle divided into 360 degrees on the limb (fig. 15.) This inſtrument is of obvious uſe to travellers, to direct them in their road; and to miners, to ſhew them what way to dig, *&c.* but it has other uſes, though leſs eaſy, yet more conſiderable, *viz.*

1. *To take the declination of a wall by the compaſs.* Apply that ſide of the compaſs whereon the north is marked along the ſide of the wall; the number of degrees over which the north end of the needle fixes, will be the declination of the wall, and on that ſide, *v. gr.* if the north point of the needle tends towards the wall, that wall may be ſhone on by the ſun at noon; if it fixes over 50 degrees, counting from the north towards the eaſt, the declination is ſo many degrees from the north towards the eaſt.

But ſince the needle itſelf declines from the north towards the weſt with us, 13°; it muſt be noted that to retrieve the irregularity, 13° are always to be added to the degrees ſhewn by the needle, when the declination of the wall is towards the eaſt; on the contrary, when the declination is towards the weſt, the declination of the needle to be ſubſtracted.

2. If we want to take an angle with the compaſs. Suppoſe the angle required be D A E (fig. 11.) we'll apply the ſide of the *compaſs* whereon the north is marked to one of the lines A D, obſerving, when the needle reſts, the degrees at which

which its north point ſtands, which ſuppoſe 80: ſo many degrees does the line decline from the meridian.

In the ſame manner take the declination of the line A E, which ſuppoſe 215°; ſubſtract 80° from 215, the remainder is 135; which ſubſtracted from 188, there will remain 75°, the quantity of the angle required.

But if the difference between the declination of the two lines exceed 180°; in that caſe 180° muſt be ſubſtracted from that difference: the remainder is the angle required. We'll ſee the method of laying this on paper, when I'll ſpeak of plotting.

In meaſuring angles by the *compaſs*, there needs not any regard to be had to the variation; that being ſuppoſed the ſame in all the lines of the angles.

3. If it be wanted to *take the plot of a field by the compaſs*. Suppoſe A, B, C, D, E, (fig. 12.) to be the field. For the greater accuracy let there be two ſights fitted to the meridian line of the *compaſs*, place it horizontally, and through the ſights look along the ſide A B, or a line parallel to it; applying the eye to the ſight at the ſouth point of the *compaſs*, draw a rough ſketch of the field by the eye, and on the correſponding line enter down the degree to which the needle points, which ſuppoſe 90; meaſure the length of the ſide, and enter that too, which ſuppoſe 10 chains.

In this manner proceed with all the reſt of the ſides and angles of the field; the ſides which ſuppoſe 70, 65, 70, 50, 94 chains; and the angle which ſuppoſe 30, 100, 130, 240, 300 degrees.

To protract the field, ſet down the ſeveral angles obſerved one after another; and ſubſtract the leſſer from the next greater: thus you will have the quantity of the ſeveral angles, and the length of the lines that will include them. More of this under the article plotting.

All the angles of the figures taken together, muſt make twice as many right angles, abating two.

We have thus far given the deſcription of the inſtruments uſed in the former part of the firſt branch of ſurveying; and of the different uſes thereof; therefore we proceed to the explication of the latter part of our firſt diviſion.

The *latter part* is performed by means either of the *chain*, or the *perambulator*.

The PERAMBULATOR, is an inſtrument for the meaſuring of diſtances, called alſo *pedameter*, *way wiſer*, and *ſurveying wheel*. Its advantages are its handineſs and expedition: its contrivance is ſuch, that it may be fitted to the wheel of a coach; in which it performs its office, and meaſures the road without any trouble at all. There is ſome difference in its make: that now moſt in uſe as moſt convenient, is as follows.

The *perambulator*, (fig. 23) conſiſts of a wheel two feet ſeven inches and a half in diameter; conſequently half a pole, or eight foot and three inches in circumference. On one end of the axis is a nut three quarters of an inch in diameter, divided into eight teeth, which upon moving the wheel round, falls into the eight teeth of another nut *c*, fixed on one end of an iron rod Q, and thus turn the rod once round, in the time the wheel makes one revolution. This rod laying along a groove in the ſide of the carriage of the inſtrument, has at its other end a ſquare hole, into which fixes the end *b*, of the little cylinder P. This cylinder is diſpoſed under the dial-plate of a movement, at the end of the carriage B, in ſuch a manner as to be moveable about its axis. Its end *a* is cut into a perpetual ſcrew, which falling into the thirty-two teeth of a wheel perpendicular thereto; upon driving the inſtrument forward, that wheel makes a revolution, each ſixteen poles. On the axis of this wheel is a pinion with ſix teeth, which falling into the teeth of another wheel of ſixty teeth, carries it round every hundred and ſixtieth pole, or half a mile.

This laſt wheel then carrying a hand or index round with it, over the diviſions of the dial-plate, whoſe outer limb is divided into one hundred and ſixty parts, correſponding to the one hundred and ſixty poles; points out the number of poles paſſed over. Again, on the axis of this laſt wheel, is a pinion, containing twenty teeth, which falling into the teeth of a third wheel that has forty teeth, drives once round in three hundred and twenty poles, or a mile. On the axis of this wheel, is a pinion of twelve teeth, which falling into the teeth of a fourth wheel that has ſeventy-two teeth, drives it once round in twelve miles.

This fourth wheel carrying another index, over the inner limb of the dial-plate, divided into twelve, for miles, and each mile ſubdivided into halves, quarters, and furlongs, ſerves to regiſter the revolutions of the other hand; and to keep account of the half miles and miles paſſed over, as far as twelve miles.

The *application* of this inſtrument is obvious from its conſtruction. Its proper office is in the ſurveying of roads, and large diſtances, where a great deal of expedition, and not much accuracy is required. It is evident that driving it along, and obſerving the hands, has the ſame effect as dragging the *chain*, and taking account of the chains and links.

The

The CHAIN, in *surveying*, is a measure consisting of a certain number of links of iron wire, usually 100; serving to take the dimensions of fields, &c. by. This is what *Merſene* takes to be the *arvipendium* of the antients.

The *chain* is of various dimensions, as the length or number of links varies: that commonly used in measuring land, called *Gunter's chain*, is in length four poles or perches, or sixty-six foot, or a hundred links, each link being seven inches $\frac{92}{100}$.

That ordinarily used for large distances, is in length 100 feet; each link one foot.

For small parcels, as gardens, &c. is sometimes used a small *chain* of one pole, or sixteen feet and a half in length; each link one inch $\frac{9}{100}$.

Some in lieu of *chains* use ropes; but these are liable to several irregularities; both from the different degrees of moisture, and of the force which stretches them. *Schwenterus*, in his practical geometry, tells us, he has observed a rope sixteen foot long, reduced to fifteen in an hour's time, by the mere falling of a hoar frost. To obviate these inconveniencies, *Wolfius* directs, that the little strands whereof the rope consists, be twisted contrary ways, and the rope dipped in boiling-hot oil, and when dry drawn through melted wax. A rope thus prepared will not get or lose any thing in length, even though kept under water all day.

The manner of applying the *chain* in measuring lengths is too popular to need description. In entring down the dimensions taken by the *chain*, the chains and links are separated by a dot: thus a line sixty-three *chains*, fifty-five links long, is wrote 63, 55. If the links be short of 10, a cypher is prefixed, thus 10 chains, 8 links, are wrote 10. 08.

If we want to *find the area of a field*, &c. *the dimensions whereof are given in chains and links*. 1. We multiply the lines by one another, and from the product we cut off five figures towards the right; those remaining on the left will be acres. 2. We multiply the five figures cut off by four; and cutting off five again from the product on the right, those remaining on the left will be roods. Lastly, we multiply the five thus cut off by forty; and cutting off five as before on the right, those remaining at the left are square perches.

To *take an angle* D A E (fig. 1.) by the chain: measure a small distance from the vertex A along each leg, *v. gr.* to *d* and *c*; then measure the distance *d c*: to lay this down, draw A E at pleasure, and from your scale set off the distance measured on it. Then taking in your compasses the length measured on the other side, on the vertex A, as a Center, describe an arch *d c*; and on the point *c*, as a center, with the measured distance of *c d*, describe another arch *a b*; through the point where this intersects the former arch, draw a line A D. So is the angle plotted; and its quantity, if required, may be measured on a line of chords.

If we want to *take the plane or plot of any place*, as A B C D E (fig. 2.) *by the* chain. We'll draw a rough sketch of the place by the eye; and measuring the several sides A B, B C, C D, D E, we'll enter down the lengths on the respective lines: then if the plan be to be taken within-side of the place, instead of measuring the angles, as before, measure the diagonals A D, B D. Thus will the figure be reduced into three triangles, whose sides are all known, as in the former case; and may be laid down on paper, according to the method above.

If the plan be to be taken without-side the place, the angles must be taken thus, *v. gr.* for the angle B C D, produce the lines B C and C D, to any certain equal distance, *v. gr.* to *a* and *b*, five *chains*; and measure the distance of *a b*. Thus have you an isosceles triangle *c a b*, wherein the angle *a c b*=B C D, its opposite one is had. Thus is the quantity of B C D found, and the angle laid down as before.

To *find, by the chain the distance between two objects inaccessible in respect of each other*. From some place, as C (fig. 3.) whence the common distance to each object A and B, is accessible in right line; measure the distance C A, which suppose fifty *chains*, and continue the line to D, *viz.* fifty more: measure also B C, which suppose thirty chains; and produce the line to E, *viz.* thirty more. Thus will be formed the triangle C D E, equal and similar to the triangle A B C; consequently the distance D E being measured, will give the inaccessible distance required.

By the chain to find the distance of an inaccessible object, v. gr. the breadth of a river. On one side place a pole, four or five foot high, perpendicularly, having a slit a-top, with a strait piece of wire, or the like, two or three inches long; put through the same. This is to be slipped up or down, till looking along it, you find it point full on the other side of the river; then turning the pole with the wire in the same direction, observe the point on the dry land, to which it points when looked along as before: measure the distance from the pole to this last point; it is the same with that of the first required. Thus far we have done with the *first branch of surveying*, properly so called.

The

The *ſecond branch of ſurveying* is performed by means of the *protractor* and *plotting ſcale*.

The PROTRACTOR, in *ſurveying*, is an inſtrument, whereby the angles taken in the field with a theodolite, circumferentor, or the like, are plotted, or laid down on paper.

The *protractor* conſiſts of a ſemicircular limb B A G, (fig. 29.) of braſs, ſilver, horn, or the like, divided into 180°, and ſubtended by a diameter B A; in the middle whereof is a little notch or lip *o*, called *the centre of the protractor*.

On the limb of the *protractor* are ſometimes alſo placed numbers, denoting the angles at the centers of regular polygons: thus, againſt the number 5, denoting the ſides of a pentagon, is found 72, the angle at the center of a pentagon.

As to *the uſe of the protractor*.— 1. To lay down an angle of any given quantity or number of degrees. Suppoſe, *e. gr.* an angle of 50°, with the line A *o* B, required on the point *o*, lay the center of the *protractor* on the given line. Make a mark againſt the given degree 5°, on the limb of the *protractor*; through which from the given point, draw a line *o p*; this gives the angle requir'd.

2. *To find the quantity of a given angle*, v. gr. the angle *p o* A, lay the center of the *protractor* on the point of the angle *o*, and the diameter on the line. The degree of the limb cut by the other line *o p*, viz. 5°, is the number of degrees of the angle requir'd.

3. *To inſcribe any given regular polygon*, e. gr. *a pentagon in a circle*. Lay the center and diameter of the *protractor* on the center and diameter of the circle; and make a dot againſt the number of degrees of the angle at the center, *viz.* 72. Through this dot, and the center of the circle, draw a line, cutting the circumference of the circle. To the point of interſection, from the point where the diameter cuts the circumference, draw a right line. This line will be a ſide of the pentagon, which being taken in the compaſſes, and ſet off, as often as it will go in the circumference, will give points, which being connected by the lines, will form the pentagon requir'd.

4. *To deſcribe any regular polygon*, e. gr. *an octagon, on a given line*. Subſtract the angle at the center, which the *protractor* gives, 45° from 180°, the remainder 135° is the angle included between two ſides of the octagon; one half whereof, is 67½, applying then the diameter of the *protractor* over the given line, with the center over one extreme; make a dot againſt 67½, to which from the center draw a line. Apply the *protractor* to the other end of the line, ſo as the center be over the extreme, and there ſet off another angle of 67½. From the point where the two lines, thus drawn, interſect as a center, deſcribe a circle with the interval of the given line. The given line will be one ſide of the octagon, which being ſet off as often as it will go in the circumference thus drawn, will give points, which being connected, will form the octagon requir'd.

The PROTRACTOR *improved* is an inſtrument much like the former, only furniſhed with a little more apparatus, whereby we are enabled to ſet off an angle to a minute; which is impracticable in the other.

The chief addition is an index fitted on the center, and moveable thereon; ſo as to play freely and ſteadily over the limb. Beyond the limb, the index is divided on both edges, into 60 equal parts of the portions of circles, intercepted by two other right lines drawn from the center; ſo as each makes an angle of one degree, with lines drawn to the aſſumed points from the center.

To ſet off an angle of any number of degrees and minutes, with this *protractor*. Move the index, ſo that one of the lines drawn on the limb, from one of the fore-mentioned points, may fall upon the number of degrees given; and pick off as many of the equal parts on the proper edge of the index, as there are minutes given; thus drawing a line from the center, to that point ſo pricked off, you have an angle with the diameter of the *protractor* of the propoſed number of degrees and minutes.

Indeed it may be of good uſe to lay down an angle to a minute, when we are able to take it to a minute; but till we have other ſorts of needles, and juſter theodolites, than are yet made, the old *protractor* may ſerve very well.

The PLOTTING *ſcale*, is an inſtrument uſually made of wood, ſometimes of braſs, or other matter; and either a foot, or half a foot long. On one ſide of the inſtrument, (fig. 32.) are ſeven ſeveral ſcales or lines, divided into equal parts. The firſt diviſion of the firſt ſcale, is ſub-divided into ten equal parts, to which is prefixed the number 10, ſignifying that 10 of thoſe ſub-diviſions make an inch; or that the diviſions of that ſcale are decimals of inches.

The firſt diviſion of the ſecond ſcale is likewiſe ſub-divided into 10, to which is prefixed the number 16, denoting that 16 of thoſe diviſions make an inch. The firſt diviſion of the third ſcale is ſub-divided in like manner into 10, to which is prefixed the number 20. To that of the fourth ſcale is prefixed the number 24: to that of the fifth 32; that of the ſixth 40; that of the ſeventh 48; denoting the number of ſub-diviſions equal to an inch, in each reſpectively.

The

The two laſt ſcales are broken off before the end, to give room for two hours of chords marked by the letter *c c*.

On the backſide of the inſtrument is a diagonal ſcale, the firſt of whoſe diviſions, which is an inch long, if the ſcale be a foot, is ſub-divided, diagonally, into 100 equal parts. At the other end of the ſcale is another diagonal ſub-diviſion, of half the length of the former, into the ſame number of parts, *viz.* 100.

Next the ſcales is a line divided into a hundredth part of a foot, number'd 10, 20, 30, *&c.* and a line of inches divided into tenth parts, marked 1, 2, 3, *&c.*

The *plotting-ſcale* is uſed in the following manner.—1. *Any diſtance being meaſured with the chain, to lay it down on a paper.*—Suppoſe the diſtance to be 6 chains, 50 links, draw an indefinite line; ſet one foot of the compaſſes at figure 6, on the ſcale, *e. gr.* the ſcale of 20 in an inch, and extend the other to 5 of the ſub-diviſions, for the 50 links: this diſtance being transferred to the line, will exhibit the 6 chains, 50 links, required.

If it be deſired to have 6 chains, 50 links, take up more or leſs ſpace, take them off from a greater or leſſer ſcale, *i. e.* from a ſcale that has more or leſs diviſions in an inch.

To find the chains and links contained in a right line, e. gr. *that juſt drawn, according to any ſcale*, e. gr. *that of* 20 *in an inch.*—Take the length of the line in the compaſſes, and applying it to the given ſcale, you will find it extend from the number 6 of the great diviſions, to 5 of the ſmall ones: hence the given line contains 6 chains, 50 links.

From this *plotting ſcale*, this ſecond branch of *ſurveying*, borrows its name of *plotting*.

In *ſurveying* with the *plain table*, the plotting is ſaved; the ſeveral angles and diſtances being laid down on the ſpot, as faſt as they are taken, as we have obſerved in the firſt branch of *ſurveying*.

But in working with the theodolite, ſemicircle, or circumferentor, as the angles are taken in degrees; and the diſtances in chains, and links; there remains an after-operation, to reduce thoſe numbers into lines, and ſo to form a draught, plan, or map; which operation is called *plotting*.

Plotting, then, is performed by means of two inſtruments, the *protractor*, and *plotting-ſcale*. By the former, as already obſerved, the ſeveral angles obſerved in the field with a theodolite, or the like, and enter'd down in degrees in the field-book, are protracted on paper, in their juſt Quantity.

By the latter, the ſeveral diſtances, meaſured with the chain, and enter'd down in like manner in the field-book, are laid down in their juſt proportion.

Therefore having given already ſeverally the uſe of thoſe reſpective Inſtruments, in the laying down of angles and diſtances; I ſhall here give their uſe conjointly, in the *plotting* of a field, ſurveyed either with the circumferentor or theodolite.

The *method of plotting from the circumferentor*, is thus: Suppoſe an incloſure, *e. gr.* A B C D E F G H K, fig. 21. to have been ſurveyed; and the ſeveral angles; as taken by a Circumferentor in going round the field, and the diſtances as meaſured by a chain, to be found enter'd in the field-book, as in the following table:

	Deg.	*Min.*	*Chains.*	*Links.*
A	191	00	10	75
B	197	80	6	83
C	260	30	7	82
D	325	00	6	96
E	12	24	9	71
F	324	30	7	54
G	98	30	7	54
H	71	00	7	78
K	161	30	8	22.

1. On a paper of the proper dimenſions, as L M N O, fig. 31. draw a number of parallel and equi-diſtant lines, repreſenting meridians, expreſſed in dotted lines. Their uſe is to direct the poſition of the protractor; the diameter whereof muſt always be laid, either upon one of them, or parallel thereto; the ſemi-circular lines downwards for angles greater than 180°, and upwards for thoſe leſs than 180°.

The paper thus prepared; aſſume a point on ſome meridian, as A, whereon lay the center of the protractor, and the diameter along the line. Conſult the field-book for the firſt angle, *i. e.* for the degree cut by the needle at A, which the table gives you, 191°.

Now, ſince 191° is more than a ſemicircle or 180°, the ſemicircle of the protractor is to be laid downwards; where keeping it to the point, with the *protracting pin*, make a mark againſt 191; through which mark, from A, draw an indefinite line A *b*.

The firſt angle thus protracted, again conſult the book, for the length of the firſt line A B, this you find 10 chains, 75 links. From a convenient ſcale, therefore, on the *plotting ſcale*, take the extent of 10 chains, 75 links, between the compaſſes; and ſetting one point in A, mark where the other falls in the line A *b*, which ſuppoſe in B; draw therefore the full line A B, for the firſt ſide of the incloſure.

Proceed then to the ſecond angle; and laying the ſide of the protractor on the point B, with the diameter, as before directed, make a mark, as *c*, againſt

againſt 297°, the degrees cut at B, and draw the indefinite line B *c*. On this line, from the *plotting ſcale*, as before, ſet off the length of your ſecond line, *viz.* 6 chains, 83 links; which extending from B to the point C, draw the line B C, for the ſecond ſide.

Proceed now to the third angle or ſtation: lay then the center of the protractor, as before, on the point C; make a mark, as *d*, againſt the number of degrees, cut at C, *viz.* 216; draw the indefinite line C *d*, and thereon ſet off the third diſtance, *viz.* 7 chains, 82 links; which terminating, *e. gr.* at D, draw the full line C D, for the third ſide.

Proceed now to the fourth angle D, and laying the center of the protractor over the point D, againſt 325°, the degree cut by the needle, make a mark *e*; draw the dry line D *e*, and thereon ſet off the diſtance 6 chains, 96 links, which terminating in E, draw D E for the fourth Line: and proceed to the fifth angle, *viz.* E.

Here the Degrees, cut by the needle, being 10° 24′, (which is leſs than a ſemicircle) the center of the protractor muſt be laid on the point E, and the diameter on the meridian, with the ſemicircular line turned upwards. In this ſituation make a mark, as before, againſt the number of degrees, *viz.* 12° 24′ cut by the needle at E; draw the dry line E *f*, on which ſet off the fifth diſtance, *viz.* 9 chains, 71 links; which extending from E to *f*, draw the full line E F for the fifth ſide of the incloſure.

After the ſame manner proceeding orderly to the angles F, G, H, and K; placing the protractor, making marks againſt the reſpective degrees, drawing indefinite dry lines, and ſetting off the reſpective diſtances, as above, you will have the *plot* of the whole incloſure A B C, *&c.*

Such is the general method of *plotting* from this inſtrument; but it muſt be obſerved, that in this proceſs, the ſtationary lines, *i. e.* the lines wherein the circumferentor is placed to take the angles, and wherein the chain is run to meaſure the diſtances, are properly, the lines here *plotted*. When, therefore, in *ſurveying*, the ſtationary lines are at any diſtance from the fence or boundaries of the field, *&c.* Off-ſets are taken, *i. e.* the diſtance of the fence from the ſtationary line, is meaſured at each ſtation; and even at intermediate places, if there prove any conſiderable bends in the fence.

In *plotting*, therefore, the ſtationary lines being laid down as above, the off-ſets muſt be laid down from them, *i. e.* perpendicular of the proper length, let fall at the proper places from the ſtationary lines. The extremes of which perpendiculars being connected by lines, give the *plot* deſired.

If inſtead of going round the field, the angles, and diſtances have been all taken from one ſtation; the proceſs of *plotting* is obvious from the example above: all here required, being to protract, after the manner already deſcribed, the ſeveral angles and diſtances, taken from the ſame ſtationary pin in the field; from the ſame point or center on the paper. The extremities of the lines thus determined, being then connected by lines, will give the plot required.

The method of *plotting*, where the angles are taken by the theodolite, *i. e.* by back-ſight and fore-ſight, as it is called, is ſomewhat different.

To prepare the angles for *plotting*, the quantity of each muſt be firſt found, by ſubſtracting the degree of back-ſight and fore-ſight from each other: the remainder is the angle to be protracted.

The uſe of parallel lines is here excluded, and inſtead of laying the protractor conſtantly on, or parallel to meridians; its direction is varied at every angle. The practice is thus:

Suppoſe the former incloſure to have been ſurveyed with the theodolite, after the manner of back-ſight and fore-ſight, and ſuppoſe the quantity of each angle to be found by ſubſtraction. An indefinite line is drawn at random, as A K, fig. 31, and on this the meaſured diſtance, *e. gr.* 8 chains, 22 links, ſet off, as in the former example: if now the quantity of the angle A have been found 140°, the diameter of the protractor is to be laid on the line A K, with the center over A, and againſt the number of degrees, *viz.* 140, a mark made an indeterminate dry line drawn through it, and the diſtance of the line A B laid down from the ſcale thereupon.

Thus we gain the point B; upon which laying the center of the protractor, the diameter, along with the line A B, the angle B is protracted, by making a mark againſt its number of degrees, drawing a dry line, and ſetting off the diſtance B C as before.

Thus proceed to C, laying the diameter of the protractor on B C, the center on C, protract the angle C, and draw the line C D: thus proceeding, orderly, to all the angles and ſides, you will have the plot of the whole incloſure A B C, *&c.* as before.

The *third branch of* Surveying is performed, by reducing the ſeveral diviſions, incloſures, *&c.* into triangles, ſquares, trapeziums, parallelograms, *&c.* but eſpecially triangles; and finding the areas or contents of theſe ſeveral figures, by the following rules; which I'll begin by thoſe relating to *areas*.

An Area is the ſuperficial content of any figure.—Thus, if a figure, *e. gr.* a field be in form

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TANNER'S WORK-SHOP.

of a ſquare, and its ſide 40 foot long, its area is ſaid to be 1600 ſquare feet, or contain 1600 little ſquares, each a foot every way.

Hence to find the *area* of a triangle, ſquare, parallelogram, rectangle, trapezium, rhombus, polygon, circle, or other figure, is to find the magnitude, or capacity thereof, in ſquare meaſure.

To find the *area* of fields, and other incloſures, they firſt ſurvey or take the angles thereof, then plot them on paper, and thus caſt up their contents, acres, roods, *&c.* after the uſual manner of other plain figures.

This laſt branch of *ſurveying* belongs more properly to *trigonometry*: therefore I'll refer to that treatiſe, all that can be ſaid relating to it.

TANNING.

TANNING is the art of preparing of ſkins or hides in a pit, with *tan* and water.

What we call *tan*, in this preparation (from which the art borrows its name) is the bark of oak, chapped and ground, by a tanning-mill, into a coarſe powder.

Not only the bark, but every part of the oak-tree, of what age or growth ſoever, all oaken coppice, *&c.* cut in barking time, makes good *tan*; as good at leaſt as the beſt bark.

This when got is to be well dried in the ſun, houſe-dry'd, and kept ſo. To uſe it, the greater wood may be ſhaved ſmall, or cleft, fit to be cut ſmall by a tanning engine for the purpoſe; which done, it is well dried again on a kiln, and then ground by the mill. Where oak is ſcarce, thorns may ſupply the defect.

New tan is the moſt eſteemed; when old and ſtale, it loſes a deal of its effect, which conſiſts in condenſing, or cloſing the pores of the ſkin; ſo that the longer the ſkins are kept in *tan*, the greater ſtrength and fineneſs they acquire.

The operation of *tanning* regards only bullocks, cows, calves, and horſe-hides; the method thereof, for bullocks or oxes hides, is as follows:

The ſkin being ſlead off the carcaſs, if it is intended to be kept, it is ſalted with ſea-ſalt and allum, or with a kind of ſaltpetre called *natron*, if it is not for keeping, the ſalting is ſaved, as being of no uſe, but to prevent the hide from corrupting before it can be conveniently carried to the tan-houſe.

Whether the hides have been ſalted or not, the *tanner* begins with taking off the horns, the ears, and the tail; after which it is thrown into a running water for about thirty hours, to waſh off the blood, and other impurities adhering to the inſide.

This done, it is laid over-night in a lime-pit, already uſed; whence it is taken, and left to drain three or four days on the edge of the pit.

This firſt and ſlighteſt preparation over, it is returned into a ſtrong lime-pit for two days, then taken out for four more; and thus for ſix weeks alternately, taken out and put in twice a week.

At the ſix weeks end it is put into a freſh pit, where it continues eight days, and is taken out for ſo many; and this alternately for a year or eighteen months, according to the ſtrength of the leather, or the weather. For in great heat they put in freſh lime twice a week; and in froſt they ſometimes do not touch them for three months. Every freſh lime-pit they throw them into is ſtronger and ſtronger.

At four, five, or ſix weeks end, the *tanner* ſcrapes off the hair on a wooden leg or horſe, with a kind of kniſe for that purpoſe. And after a year or eighteen months, when the hair is perfectly gone, he carries it to a river to waſh, pares off the fleſh on the leg with a kind of cutting kniſe, and rubs it briſkly with a kind of whet-ſtone, to take off any remains of fleſh or filth on the ſide of the hair.

The ſkin is now put into *tan*; that is, cover'd over with *tan*, as it is ſtretched in the pit, and water let in upon it: if the ſkin be ſtrong, five coverings of *tan* will be required; for weaker, three or four may ſuffice. When the ſkin has not been kept long enough in lime, or the *tan-pit* is upon clearing it, in the middle is ſeen a whitiſh ſtreak, called the horn, or crudity of the ſkin; and this is the reaſon why the ſoals of ſhoes, boots, *&c.* ſtretch ſo eaſily, and take water.

When the hides are ſufficiently *tanned*, they are taken out of the pit to be dried, by hanging in the air. Then the *tan* is cleaned off them, and they are put in a place neither too dry, nor too moiſt; they are well ſtretched over one another, with weights a-top, to keep them tight and ſtraight; and under this condition are ſold under the denomination of *bind leather*.

Cows, calves, and horſes ſkins are *tanned* much after the ſame manner as thoſe of oxen, except that the former are only kept four months in the lime-pit; and that before they be put in the *tan*, there is a preparation required thus: cold water is

poured into a wooden fat or tub, wherein the skins are put, which are kept stirring, while some other water is warming in a kettle; and as soon as that water is a little more than luke-warm, it is poured gently into the fat, and upon this is cast a basket of *tan*; during which time, the skins are still kept turning, that the water and tan may not scorch them.

After an hour they are taken out, and cast for a day in cold water, then returned into the former fat, and the same water they had been in before; and here they are left eight days; which expired, they are put in the *tan-pit*, and three coverings of *tan* given them, the first of which lasts five weeks, the second six, and the third two months.

The rest of the process is in all respects the same as that above delivered. In some countries, as *Champagne*, &c. the *tanners* give the first preparation with barley instead of lime.

See SHAMOISING *in Letter S.*

THEOLOGY.

THEOLOGY, or DIVINITY, a science which instructs us in the knowledge of God, or divine things; or which has God, and the things he has revealed, for its object.

Hence theology may be distinguished into natural, which comprehends the knowledge we have of God from his works, by the light of reason alone; and supernatural, which contains what we are taught concerning God in revelation.

Theology is again distinguished into positive, moral, and scholastic. Positive theology is the knowledge of the holy scriptures, and of the signification thereof, conformably to the opinions of the fathers and councils, without the assistance of any argumentation. Some will have it, that this ought to be called expositive, rather than positive. Moral theology, is that which teaches us the divine laws relating to our manners and actions. Scholastic, or school theology, is that which proceeds by reasoning; or that derives the knowledge of several divine things from certain established principles of faith.

TRIGONOMETRY.

TRIGONOMETRY is the art of finding the dimensions of the parts of a triangle unknown, from other parts known; or the art whereby from any three parts of a triangle given, all the rest are found.

The Word literally signifies the *measuring of triangles*, formed from the *Greek* τριγωνον, *triangle*, and μετρεω, *measure*. Yet does not the art extend to the measuring of the area, or surface of *triangles*, which comes under *geometry*: *trigonometry* only considers the lines and angles thereof.

Trigonometry, or the solution of *triangles*, is founded on that mutual proportion, which is between the sides and angles of a *triangle*; which proportion is known, by finding the proportion which the radius of a circle has to certain other lines, called *chords*, *sines*, *tangents*, and *secants*.

This proportion of the sines and tangents to their radius, is sometimes expressed in common or natural numbers, which constitute what we call the *tables of natural sines and tangents*, &c. Sometimes it is expressed in logarithms, and in that case constitute *the Tables of artificial sines*, &c.

Lastly, sometimes the proportion is not expressed in numbers; but the several *sines*, *tangents*, &c. are actually laid down upon *lines* or *scales*; whence the *line of sines*, *tangents*, &c.

Note, That before I proceed to the division of *trigonometry*, I must explain what is understood by *sines*, *tangents*, and *secants in trigonometry*.

SINE, or *right* SINE, in *trigonometry*, is a right line drawn from an extremity of an arch, perpendicularly upon the radius drawn from the other extremity; or the *sine* is half the chord of twice the arch.

Whole SINE, *sine totus*, is the sine of a quadrant, or of 90 degrees; that is, the whole sine is the same with the radius.

Versed SINE is a part of the whole *sine* or radius, intercepted between the right *sine* and the arch.

It is demonstrated, 1. that the right *sine*, being perpendicular to the radius; all *sines* drawn to the same radius are parallel to each other.

2. Two angles contiguous have the same *sine*.

3. The *sines* of obtuse angles are the same with those of their complements to two right angles.

4. All *sines* of similar arches have the same ratio to their radii.

SINE-

SINE-*complement*, or *co*-SINE, is the ſine of an arch, which is the complement of another arch to a quadrant.

In eſtimating the quantity of *ſines*, &c. we aſſume the radius for unity, and determine the quantity of the *ſines*, *tangents* and *ſecants* in fractions thereof. From *Ptolemy*'s *almageſt*, we learn that the ancients divided the radius into 60 parts, which they called degrees, and thence determined the chords in minutes, ſeconds and thirds, that is in ſexageſimal fractions of the radius; which they likewiſe uſed in the reſolution of *triangles*. The *ſines* of half chords, for ought appears, were firſt uſed by the *Saracens*.

Regiomontanus, at firſt, with the antients, divided the radius into 60 degrees; and determined the *ſines* of the ſeveral degrees into decimal fractions thereof, but he afterwards found it would be more commodious to aſſume the radius for one; and thus introduced the preſent method into *trigonometry*.

In the common tables of *ſines* and *tangents* the radius is conceived divided into 10000000 parts; beyond which we never go in determining the quantity of the *ſines* and *tangents*. Hence, as the ſide of a hexagon ſubtends the ſixth part of a circle, and is equal to the radius; the ſine of 30° is 5000000.

1. *The ſine being given to find the ſine-complement.* From the ſquare of the radius, ſubſtract the ſquare of the *ſine*: the remainder will be the ſquare of the *ſine-complement*: whence the ſquare root being extracted, gives the *ſine-complement*.

2. *The ſine of the arch being given, to find the ſine of the half arch.* Find the chord of the arch, for half of this is its *ſine*.

3. *The ſine of an arch being given to find the ſine of a double arch.* This is found by the rule of *proportion*.

To conſtruct a canon of SINES. The *ſines* of 30°, 15°, 45° 36° being had, we can thence conſtruct a cannon of all the *ſines* to every minute, or every ſecond, for from the *ſine* of 36°, we find thoſe of 18°, 9°, 4°, 30′; and 2°, 15′, by the ſecond problem: the *ſines* of 54°, 72°, 81°, 85°, 30′, and 87°, 45′, &c. by the firſt problem. Again, from the *ſine* of 45° find the *ſine* of 22°, 30′; 11°, 15′, &c. From the *ſines* of 30° and the *ſines* of 54° find the *ſign* of 12°. From the *ſine* of 12° find the *ſines* of 6°, 3°, 1°, 30′. 35′; 78°, &c. From the *ſine* of 15°, find the *ſine* of 7, 30′, 45′, &c. 'till you have 120 *ſines* ſucceding each other orderly, at an interval of 45 minutes. Between theſe find the intermediate *ſine*: thus will the canon be compleat. From the *ſine* I'll paſs to the explication of the *tangent*.

TANGENT in *trigonometry*, is a right line arched perpendicularly on the extreme of the diameter of an arch, and continued to a point, where it is cut by a ſecant, that is, by a line drawn from the centre, through the extremity of the arch, whereof it is a *tangent*.

CO-TANGENT, or TANGENT *of the compliment*, is the *tangent* of an arch, which is the complement of another arch to a quadrant.

Artificial TANGENTS are the logarithms of the *tangents* of arches.

Sine of TANGENTS is a ſine uſually placed on the ſector and Gunter's Scale.

TANGENT *of a conic ſection*, as of a parabola, is a right line which only touches or meets the curve in one point, and does not cut or enter within the curve.

The method of *tangents* is a method of determining the quantity of the *tangent* of any algebraic curve; the equation defining that.

This method is one of the great reſults of the *calculus differentialis*.

SECANT, in *trigonometry*, denotes a right line, drawn from the centre of a circle, which cutting the circumference, proceeds 'till it meets with a tangent to the ſame circle.

To find the logarithm of the *ſecant* of any arch, the ſine of the complement of the arch being given, multiply the whole ſine of the logarithm by two, and from the product, ſubſtract the logarithm of the ſine complement; the remainder is the logarithm of the *ſecant*.——from this I'll paſs to the diviſion of *trigonometry*.

TRIGONOMETRY, is divided into *plain*, and *ſpherical*; the firſt conſidering rectilineal triangles; and the ſecond ſpherical ones.--The firſt is of obvious and continual uſe in navigation, meaſuring, ſurveying, and other operations of geometry.

The ſecond is only learned with a view to aſtronomy, and its kindred arts, geography, and dialing.-----It is generally eſteemed exceeding difficult, by reaſon of the vaſt number of caſes wherewith it is perplex'd; but the excellent *wolfius* has remov'd moſt of the difficulties. That author has not only ſhewn how all the caſes of rectangled triangles may be ſolved the common way, by the rules of ſigns and tangents; but has likewiſe laid down an univerſal rule, whereby all problems, both in plain and ſpherical rectangled triangles, are ſolved; and even obliquangular triangles he teaches to ſolve with equal eaſe.

Plain TRIGONOMERTY is an art whereby, from three given parts of a plain triangle, we find the reſt.

The great principle of *plain trigonometry* is, that in every plain triangle, the ſides are, as the ſines

of the oppoſite angles: the doctrine thereof, which is that of the learned *Wolfius*, is contained in the following problems.

For the *ſolution of the plain triangles*. ----- 1. Two angles being given, together with a ſide oppoſite to one of them; to find the ſide oppoſite to the other, the rule or canon is this; as the ſine of the angle, is to the given ſide oppoſite to the ſame; ſo is the ſine of the other angle, to the ſide required; the oppoſite ſide therefore is commodiouſly found by the logarithms, from the rule for finding a fourth proportional to the three numbers given.

For an example; ſuppoſe one of the given angles=78° 35′. and the other=57° 28, the ſide oppoſite to one of them=74′, the operation will ſtand thus.

Logar. of ſine of one angle	9. 8750142
Logar. of the oppoſite ſide	1. 8692317
Logar. of ſine of the other angle	9. 9258681
Sum of logar. of the oppoſite ſide, and of the ſine of one angle	11. 7950998
Log. of the ſide oppoſite to the other	1. 9200856

The number correſponding to which in the table of logarithms, is 83, the quantity of the ſide ſought.

2. Two ſides together with the angle oppoſite to one of them given; to find the other angles. ——The rule is this; as one ſide is to the ſine of the given angle oppoſite thereto; ſo is the other ſide, to the ſine of the angle required oppoſite thereto.

For example, ſuppoſe one of the ſides=94′, and the other ſide=63′, the angle oppoſite to one of them=72° 15′.

Log. of one ſide	1. 9731279
Log. of the ſine of the angle	3. 9788175
Log. of the other ſide	1. 8388491
Sum of loga. of ſine of the oppoſite angle, and of one of the ſides	11. 8176666
Logar. of ſine of the other ſide	9. 9444387

The number correſponding to which, in the table of logarithms, is 61° 37′, now the given angle being 72°, 15′, the ſum of the two 133° 52′ ſubtracted from 18°, the ſum of the three gives 46° 8′, for the other angle ſought.

In like manner, ſuppoſe, in a right angled triangle, that beſide the right angle, is given the hypothenuſe, 49, and the cathetus, 36, to find the angle ſought; then will the operation ſtand thus:

Log. of the hypot.	1. 6901961
Log. of the whole ſine	10. 0000000
Log. of the cathetus	1. 5563025
Log. of ſine of the angle ſought	9. 8661064

The correſponding number to which, in the table of logarithms, is 47° 16′.

3. Two ſides, together with the included angle being given, to find the two remaining angles. ——1. If the triangle be rectangular, take one of the ſides including the right angle, for radius, then will the other ſide be the tangent of the oppoſite angle.—The rule then is, as one leg is to the other; ſo is the whole ſine to the tangent of the oppoſite angle.

E. gr. ſuppoſe one of the ſigns 79. and the other 54.

Log. of one ſide	18976271
Log. of the other	17323938
Log. of the whole ſine.	100000000
Logar. of Tang. of the angle ſought	9. 8247667

The correſponding number to which, in the table of logarithms, is 34° 21′, therefore one of the angles of the triangle is 55° 39′.

II. If the included angle be oblique, the rule is; as the ſum of the given ſides, is to their difference, ſo is the tangent of half the ſum of the ſought angles, to the tangent of half the difference; adding, therefore, the half difference to the half ſum; the aggregate will be the greater angle; and ſubtracting the half difference from the half ſum, the remainder is the leſs angle.

As for example, ſuppoſe the given ſides=75′, =58′, the oblique angle=180° 24′, then will the given ſides,

75 = 75		
58 = 58	+	179° 60′
		118° 24 the oblique angle.
Sum 133 diff. 17		71° 30′ ſought angles
		35° 48′½ thereof

Log. of the given ſides	2. 1238516
Log. of the angles ſought	1. 2334489
Log. of tangent ½	9. 8580695
Sum of log.	12. 0885183
Log of tangent ½	8. 9646667

The correſponding number to which is 5° 16′.

Spherical TRIGONOMETRY, is the art whereby from the three given parts of a ſpherical triangle, we find the reſt, *e. gr.* from two ſides and one angle, we find the two other angles, and the third ſide.

The

The principles of *ſpherical trigonometry*, as reformed by *Wolfius*, are as follows. 1. In every rectangled ſpherical triangle, the whole ſine is to the line of the hypothenuſe, as the ſine of either of the acute angles, is to the ſine of the leg oppoſite thereto, or the ſine of the angle to the ſine of its oppoſite leg; whence we deduce, that the rectangle of the whole ſine, into the ſine of one leg, is equal to the rectangle of the ſine of the angle oppoſite thereto, into the ſine of the hypothenuſe.

2. In every right angled ſpherical triangle, none of whoſe ſides is a quadrant; if the complements of the legs to a quadrant, be conſidered as the legs themſelves: the rectangle of the whole ſine into the co-ſine of the middle part, is equal to the rectangle of the lines, disjunct parts, or extremes.

Hence, 1. If the line be artificial, that is, the logarithms of the natural ones; the whole ſine, with the co-ſine of the middle part, will be equal to the ſines of the disjunct part.

2. Since, in a rectangular triangle, the whole ſine is to the hypothenuſe, as the ſine of the angle, to the ſine of the oppoſite leg; if inſtead of the ſines of the ſides, we take the ſides themſelves; here, too, the whole ſine, with the co-ſine of the middle part, will be equal to the ſine of the diſjunct parts.

This *Wolfius* calls *regula ſinuum catholica*, or the firſt part of the *catholick rule* of *trigonometry*; by means whereof all the problems of either *trigonometry* are ſolved, when the thing is effected by ſines alone.—My Lord *Napier* had the firſt thought of ſuch a rule; but he uſed the complements of the hypothenuſe, and the angles, for the hypothenuſe and angles themſelves: ſo that the tenor of his catholick rule is this:

The whole ſine, with the ſine of the middle part, is equal to the co-ſines of the disjunct, or as he calls them, oppoſite parts.—But in this, that harmony between plain and ſpherical *trigonometry*, viſible in *Wolfius*'s rule, does not appear.

3. In a rectangled ſpherical triangle, none of whoſe ſides is a quadrant; as the whole ſine is to the ſine of the adjacent leg; ſo is the tangent of the adjacent angle, to the tangent of the leg.

Whence, 1. As the co-tangent of the angle, is to the whole ſine, as the whole ſine is to the tangent of the angle, ſo is the ſine of the adjacent leg, to the tangent of the other leg; therefore the co-tangent of the adjacent angle, will be to the whole ſine, as the ſine of the leg adjacent thereto, is to the tangent of the oppoſite one. 2. The rectangle, therefore, of the whole ſine, into the ſine of one leg, is equal to the rectangle of the tangent of the other leg, into the co-tangent of the angle oppoſite to the ſame. And, in like manner, the rectangle of the whole ſine, into the ſine of one of the legs, is equal to the rectangle of the tangent of the adjacent leg, into the co-tangent of the angle ſought.

4. In every right angled ſpherical triangle, none of whoſe ſides is a quadrant; if the complements of the legs to a quadrant, or their exceſſes beyond a quadrant, be conſidered as the legs themſelves; the rectangle of the whole ſine, into the co-ſine of the middle part, will be equal to the rectangle of the co-tangents of the conjunct parts. 2. Since in a rectilinear, right angled triangle, we uſe the tangents, when from the legs given, the adjacent angle is to be found; and in that caſe the whole ſine is to the co-tangent of the angle, as one leg to the other; therefore, alſo, in a rectilinear triangle, if for the ſines and tangents of the ſides, be taken the ſines themſelves; the whole ſine, with the co-ſine of the middle part, is equal to the co-tangents of the conjunct parts.

This *Wolfius* calls *regula tangentium catholica*, and conſtitutes the other part of the catholick rule of *trigonometry*; whereby all problems, in each *trigonometry*. where tangents are required, are ſolved.

My Lord *Napier*'s rule to the like effect is thus.—That the whole ſine, with the ſine of the middle part, is equal to the tangents of the contiguous parts.

'Tis therefore a catholick rule, which holds in all *trigonometry*, that in a rectangled triangle, (*notatis notandis*) the whole ſine, with the co-ſine of the mean or middle part, is equal to the ſines of the disjunct or ſeparate parts, and the co-tangents of the conjunct or contiguous part.

For an illuſtration and application of this rule, we'll give the ſolution of the various caſes of ſpherical triangles, *viz.*

Solution of right angled ſpherical TRIANGLES by the common rules, 1. In a right angled *ſpherical triangle*, any two parts, beſides the right angle, being given to find the reſt.

1. Conſider whether the parts, which come to the queſtion be conjunct or diſjunct. If the diſjunct be oppoſite to each other; as, if the hypothenuſe and an angle be given, to find the oppoſite leg. Then the rule is; as the whole ſine is to the ſine of the hypothenuſe, ſo is the ſine of the angle to the ſine of the oppoſite leg. 2. If the disjunct parts be not oppoſite to each other, the ſides of the *triangle* are to be continued one way, till they become quadrants, that you may thus have a new *triangle*, wherein the parts that come into the queſtion, are mutually oppoſite to each other.

3. If the hypothenuſe be not among the conjunct parts, as if the legs be given for an angle oppoſite to one of them, the rule is—As the ſine of

of one of the legs is to the whole sine, so is the tangent of the other leg to the tangent of the angle.

4. But if the hypothenuse be found among the conjunct parts, as if the hypothenuse and the angle be given, to find the adjacent side; the sides of the triangle are to be continued one way, till they become quadrants, that we may have a new *triangle*, wherein the *hypothenuse* is not among the parts that come into the question; *e. gr.* in our case, the *triangle*, wherein are given the complement of the *hypothenuse*, and the complement of an angle, and another angle the complement of the leg; since then in the *triangle* the *hypothenuse* does not come in question, the rule is as before.

5. When the sides of a *triangle* are to be continued, it is the same thing which way soever they be produced, provided no acute angle come into the question, otherwise the sides are to be continued through the other oblique one. If both be in the connection, the sides are to be continued through that adjacent to the side in question.

By this means a *triangle* is always obtained, wherein the thing required is found, either by the rules of sines or tangents.

Solution of right angled spherical TRIANGLES, *by a catholick rule.*—Consider, as before, whether the parts that come in question be conjunct or disjunct.

If either one, or both the sides, including the right angle, come into the question; for it, among the data, writes its complement to a quadrant. Since, then, by the catholick rule already delivered, the whole sine, with the sine complement of the middle part, is equal to the sines of the disjunct parts, and the co-tangents of the conjunct parts; from the sum of those data subtract the third datum; the remainder will be some sine or tangent, the sine or angle corresponding to which, in the artificial canon of *triangle*, is the side or angle sought.

This universal rule being of great service in *trigonometry*, we shall apply it to the various cases thereof, and illustrate it with examples; which examples in the case of disjunct or separate parts, will, at the same time, illustrate the common method, but in the case of contiguous parts admit of other solutions.

The *hypothenuse* 60°, and the angle 23° 30′, being given, to find the opposite leg. Since the opposite leg is the middle part, the angle an hypothenuse are disjunct; the whole sine, with the co-sine of the complement of the leg, *i. e.* with the whole sine of the leg, is equal to the sines of the angle and hypothenuse.

Therefore from the sine of the angle	96006997
Sine of the hypothenuse	99375306
Sum	195382303
Subtract the whole sine	100000000
Remain sine of the hypoth.	9.5382303

the corresponding number to which, in the canon, is 20°, 12′, 6″.

2. Given the hypothenuse 60°, and one of the legs, 20°, 12′, 6″, to find the opposite angle.—It is evident from the preceding problem, that from the sum of the whole sine, and the sine of the leg, the sine of the hypothenuse is to be subtracted, the remainder is the sine of the angle. The example, therefore, of the former case, is easily converted into an example of this.

3. Given the leg 20°, 12′, 6″, and the opposite angle 23°, 30′, to find the hypothenuse.—'Tis evident from the first case, that from the sum of the whole sine, and the sine of the leg, is to be subtracted the sine of the angle, and the remainder is the sine of the hypothenuse.

4. Given the hypothenuse 60°, and one leg 20°, 12′, 16″, to find the other leg.—Since the hypothenuse is a mean part, and the two legs are disjunct parts, the whole sine, with the co-sine of the hypothenuse, are equal to the sines of the complements; *i. e.* to the co-sines of the two legs.

Therefore from the whole sine	100000000
Co-sine of the hypothenuse	96989700
Sum	196989700
Subtract co-sine of a leg	99724279
Remains co-sine of the other leg	97265421

the corresponding number to which, in the canon, is 32°, 11′, 34″; therefore the leg sought, 57°, 48′, 26″.

5. Given this leg 57° 48′ 26″, and the other leg 20° 12′ 6″. to find the hypothenuse. 'Tis evident from the preceding case, that the whole sine is to be subtracted, from the sum of the co-sines of the two legs; the remainder is the co-sine of the hypothenuse. The example, therefore, of the preceding case is easily applied to this.

6. Given the leg 57° 48′ 26″, and the adjacent angle 23° 30′, to find the opposite angle.—Since the opposite angle is a middle part, and the leg and adjacent angle disjunct parts; the whole sine, with the co-sine of the opposite angle, is equal to the sine of the adjacent angle, and the sine of the complement, *i. e.* to the co-sine of the leg.

Therefore

Therefore from the fine of the adjacent angle	96006997
Co-fine of the leg	97265421
Sum	193272418
Subſtract the whole fine	100000000
Remains co-fine of the oppoſite angle:	93272418,

The number correſponding to which, in the canon, is 12° 15′ 56″; therefore the oppoſite angle is 77° 44′ 4″.

7. Given the leg 57° 48′ 26″, and the oppoſite angle 77° 44′ 4″, to find the adjacent angle.—'Tis evident from the preceding caſe, that the co-fine of the leg is to be ſubſtracted from the ſum of the whole fine, and the co-fine of the oppoſite angle; the remainder is the fine of the adjacent angle. The former example, therefore, is eaſily accommodated to the preſent caſe.

8. Given the oblique angles 77° 44′ 4″, and 23° 30′, to find the leg adjacent to the other.—From problem the ſixth, 'tis evident, that the fine of the angle 23° 30′, is to be ſubſtracted from the ſum of the whole fine, and the co-fine of the angle 77° 44′ 4″, and that the remainder is the co-fine of the adjacent leg. The example of the ſixth Problem is eaſily applied to this.

9. Given the leg 57° 48′ 26″, and the adjacent angle 23° 30′, to find the oppoſite leg.—Since the leg 57° 48′ 26″ is a mean part; and the adjacent angle and oppoſite leg conjunct parts; the whole fine, with the fine of the leg 57° 48′ 26″, is equal to the co-tangent of the adjacent angle, and the tangent of the oppoſite leg.

Therefore from the whole fine	100000000
Sine of the leg 57° 48′ 26″	99275039
Sum,	199275039
Subſtract the co-tangent of the adjacent angle	103616981
Remains the tangent of the oppoſite leg.	95658058

to which the correſponding number in the canon, is 20° 12′ 6″.

10. Given the leg 20° 12′ 6″, and the oppoſite angle 23° 30′, to find the adjacent leg.---From the ſum of the co-tangent of the oppoſite angle, and the tangent of the given leg, ſubſtract the whole fine; the remainder is the fine of the adjacent leg.

11. Given the legs 20° 12′ 6″, and 57° 48′ 26″, to find the angle oppoſite to one of them.---From the ſum of the whole fine, and fine of the leg 57° 48′ 26″, ſubſtract the tangent of the other leg; the remainder is the co-tangent of the oppoſite angle.

12. Given the hypothenuſe 60°, and the oblique angle 23° 30′, to find the adjacent leg.---Since the oblique angle is a middle part; and the hypothenuſe and adjacent leg conjunct parts, the whole fine, with the co-fine of the oblique angle, will be equal to the co-tangent of the adjacent leg.

Therefore from the whole fine	100000000
Co-fine of the oblique angle	99623978
Sum,	199623978
Subſtract the co-tangent of the hypoth.	97614394
Remains the tangent of the adjacent leg	102009594

The number correſponding to which in the tables is, 57° 48′ 26″.

13. Given the leg 57° 48′ 26″, and the adjacent angle 23° 30′, to find the hypothenuſe. From the ſum of the whole fine, and the co-fine of the adjacent angle, ſubſtract the tangent of the leg, the remainder is the co-tangent of the hypothenuſe.

14. Given the hypothenuſe 60°, and the leg 57° 48′ 26″, to find the adjacent angle.

From the ſum of the co-tangent of the hypothenuſe, and tangent of the leg, ſubſtract the whole fine; the remainder is the co-fine of the adjacent angle.

15. Given the hypothenuſe 60°, and one angle 23° 30′, to find the other angle.

Since the hypothenuſe is the middle part, and both angles disjunct Parts, the whole fine, with the co-fine of the hypothenuſe, will be equal to the co-tangents of the two angles.

Therefore from the whole fine	100000000
Co-fine of the Hypoth.	96989700
Sum,	196989700
Subſtract the co-tangent of the angle 23° 30′	103616981
Remain the co-tangent of the other angle	93372719

the correſponding number, to which, in the canon, is 12° 15′ 56″; therefore the angle ſought is 77° 44′ 4″.

16. Given the oblique angles 77° 44′ 4″, and 23° 30′, to find the hypothenuſe.—From the ſum of the co-tangents of the angles, ſubtract the whole fine; the remainder is the co-fine of the hypothenuſe. From this I'll paſs to the *ſolution of the oblique-angled ſpherical triangles.*

1. In an *oblique-angled ſpherical triangle*, two ſides,

ſides being given together with an angle oppoſite to one of them, to find the other. The rule is,

As the ſine of one of the ſides, is to the ſine of the oppoſite angle; ſo is the ſine of the other ſide to the ſine of the angle oppoſite to it likewiſe

Suppoſe, for example, the ſide 39° 29′; the oppoſite angle 43° 20′; the other ſide 66° 45′: then will,

The ſine of the firſt ſide	98033572
The ſine of the oppoſite angle	98364771
The ſine of the other ſide	99632168
Sum	197996939
Sine of the angle, oppoſite to the ſecond ſide	99963367

the correſponding number to which, in the tables, is 82° 34′ 7″.

2. Given two angles, 82° 34′ 7″, and 43° 20′, together with the ſide 60° 44′, oppoſite to one of them; to find the ſide oppoſite to the other of them.---Say, as the ſine of the firſt angle 82° 34′ 7″, is to the ſine of the oppoſite ſide 60° 45′; ſo is the ſine of the angle 43° 20′, to the ſine of the other ſide oppoſite to it.---The former example may ſuffice for the preſent caſe.

3. Given two ſides 66° 45′, and 39° 29′, together with an angle oppoſite to one of them 45° 20′; to find the angle included by them.---Suppoſe the angle included to be acute, ſince the other angle is alſo acute, the perpendicular falls in with the triangles. In the rectangle triangle, therefore, from the given angle and ſide, find another angle. Since the perpendicular is aſſumed as a lateral part in the triangle, the third angle is a middle part, and the ſide 39° 29′ a conjoint part; the co-ſine of the third angle, and the co-tangent of the ſide 39° 29′; if then the ſecond and third angles be added together, or in caſe the perpendicular falls without the triangle, be ſubſtracted from each other; you will have the angle required.

E. gr. the whole ſine	100000000
Co-ſine of the firſt ſide	95963154
Sum	195963154
Co-tangent of the oppoſite angle	100252805
Co-tangent of the 2d angle	95710349

the Number correſponding to which, in the tables, is 20°, 25′, 35″; the firſt ſide, therefore, is 69°, 34′, 25′.

The co-ſine of the other angle	95428300.
The co-tang. of the other ſide	100141529.
Sum	196269829.
Co-tang. of the firſt ſide	96330085.
Co-ſine of the 3d angle	99938544.

The number correſponding to which, in the tables, is 80°, 24′, 26″.

4. Given two angles, 43°, 20′, and 79°, 9′, 59″, together with the adjacent ſide, 66°. 45, to find the ſide oppoſite to one of them.

From one of the given angles, let fall a perpendicular to the unknown ſide, and in the rectangled *triangle*, from the given angle, and hypothenuſe, find another angle, which, ſubſtracted from the firſt angle, leaves a third angle; but if the perpendicular ſhould fall without the *triangle*, the firſt angle ſhould have been ſubſtracted, ſince as the perpendicular is taken from one of the lateral parts, the middle part in the *triangle* is the angle 79°, 9′, 59″, the co-tangent of the ſecond ſide is found by ſubſtracting the co-ſine from the ſum of the co-tangent of the adjacent ſide, and the co-ſine of the angle found firſt of the other angles. The example of the preceding caſe is eaſily applied to this:

5. Given two ſides 66° 45′, and 39° 29′, with the angle oppoſite to one of them 43° 20′; to find the third ſide.

Letting fall, as before, the perpendicular; in the rectangled *triangle*, from the given angle and hypothenuſe, find another ſide. Since aſſuming the perpendicular, for a lateral part in the *triangle*, the ſide 66° 45′ is the middle part, and the ſide found the ſeparate part, and the two other angles a disjunct part: the co-ſine of theſe two angles is found by ſubſtracting the co-ſine of the firſt ſide, from the ſum of the co-ſines of the hypothenuſe, and the ſide found.

6. Given two angles 43° 20′, and 77° 9′ 59″, together with the ſide 39° 29′, oppoſite to one of them; to find the ſide adjacent to both.

Letting fall the perpendicular, find in the rectangled *triangle*, the ſequent of the ſide ſought; which, ſubſtracted from the third ſide, leaves two angles. If the perpendicular falls without the *triangle*, the third ſide is to be ſubſtracted from the ſide found, ſince by aſſuming the perpendicular for a literal part in the *triangle*, the hypothenuſe becomes a middle part, and the ſide found from it and the angle given, a ſeparate part.

7. Given

7. Given two angles 43°, 20′, and 79°, 9′, 59″, together with the ſide 39°, 29′, oppoſite to one of them, to find the ſide adjacent to both.

Letting fall the perpendicular from the unknown angle to the oppoſite ſide, and that falling within the *triangle*, from the given angle 79°, 9′, and 59″, and the hypothenuſe, ſeek in the rectangled *triangle* the ſegment; ſince aſſuming the perpendicular for a lateral part in one *triangle*, two angles of that triangle are the mean part, and the angle 79°, 9′, 59″, a conjuct part; and in the other triangle two angles thereof are the middle part, and the other angle a conjunct part. The ſine of the ſegment is found by ſubſtracting the co-tangent of the angle 79°, 9′, 59″, from the ſum of the ſine, and the co-tangent of the angle 43°, 20′. If then the two ſegments be added, or in caſe the perpendicular fall without the *triangle*, be ſubſtracted from each other, the reſult will be in the ſide required.

8. Given two ſides 66°, 45′, and 39°, 29′, with the included angle 49°, 9′, 59″, to find the angle oppoſite to one of them.

Letting fall the perpendicular, find the ſegment, as in the preceeding problem. This ſubſtracted from the ſide 66°, 45′, leaves another ſide. If the perpendicular falls without the triangle, the ſide 66°, 45′, is to be added. And ſince by aſſuming the perpendicular for a lateral part in the other triangle, the ſegment is the middle part, and the firſt angle given a conjunct part. The co-tangent of this angle is found by ſubſtracting the ſine from the ſum of the co-tangent of the other angle given, and of the other ſine.

9. Given two angles 43°, 20′, and 79°, 9′, 59″, together with the adjacent ſide 66°, 45′, to find the angle oppoſite to the ſame.

From one of the given angles, letting fall the perpendicular to the oppoſite ſide; in the rectangled *triangle* from the firſt given angle, and hypothenuſe, we find an angle; which ſubſtracted from the triangle, leaves another angle. In caſe the perpendicular falls without the triangle, from which this laſt angle is taken, the ſecond angle is to be ſubſtracted from the firſt angle. Since by aſſuming the perpendicular for a lateral part in the triangle, the angle oppoſite to the ſecond angle given is the middle part, and the other angle a disjunct part; and in the other triangle the firſt angle given is the middle part, and the angle found from the firſt given angle, and the hypothenuſe the disjunct part: the co-ſine of the angle oppoſite to the ſecond angle given is found by ſubſtracting the ſine of the angle taken from the firſt angle given, and the hypothenuſe from the ſum of the co-ſine of the firſt angle given, and the ſine of the angle found by the ſubſtraction of that angle.

1. Given two angles 43°, 20′, and 82°, 34′, together with a ſide 66°, 45′, oppoſite to one of them, to find the other angle.

From the ſought angle let fall a perpendicular, and in the right angled triangle, from the firſt given angle and hypothenuſe, find another angle. Since aſſuming a perpendicular for a lateral part in another triangle, the ſecond angle given is the middle part, and the other angle a disjunct part; and in the firſt triangle the firſt angle given is the middle part, and the firſt angle is found a disjunct part: the ſine of the ſecond angle found, is found by ſubſtracting the co-ſine of the firſt angle given, from the ſum of the co-ſine of the ſecond angle given, and of the ſine of the firſt *triangle*; if then the two firſt angles found be added, or in caſe the perpendicular falls without the *triangle*, be ſubſtracted from each other, the reſult will be the angle required.

2. Given the three ſides to find an angle oppoſite to one of them. 1. If one ſide be a quadrant, and the leg leſs than a quadrant, find the firſt angle. Continue the leg to a certain diſtance, till that diſtance, and the beginning of the leg become equal to a quadrant, and from the firſt pole draw an arch to cut the arch of the end of the leg and the diſtance, at right angles in the diſtance. Since in the rectangled *triangle*, we have given the hypothenuſe, and the ſide, or its complement to a quadrant, we ſhall find the perpendicular, which being the meaſure of the angle ſought, that angle is found of courſe.

2. If one ſide be a quadrant, and the other greater than a quadrant, ſeek again the firſt angle; from the ſecond ſide ſubſtract a quadrant, and from the firſt angle deſcribe an arch, cutting that arch at right angles. Since in the rectangled *triangle*, the hypothenuſe and ſide, or exceſs of the ſide beyond a quadrant is given, the perpendicular C.D. will be found as before, which is the meaſure of the angle required.

Trigonometry is of the utmoſt uſe in various mathematical arts. It is by means hereof that moſt of the operations of *geometry* and *aſtronomy* are performed. Without it the magnitude of the earth and the ſtars, with diſtances, motions, eclipſes, *&c.* would be utterly unknown. *Trigonometry* therefore muſt be owned an art, whereby the moſt hidden things, and thoſe remoteſt from the knowledge of men, are brought to light. A perſon ignorant of *trigonometry* can make no great progreſs in mixed mathematicks; but will often be gravelled, even in natural philoſophy, particularly in accounting for the phænomena of the rainbow and other meteors.

TURNING.

TURNERY, or TURNING, is the art of faſhioning hard bodies, as braſs, ivory, wood, *&c.* into a round or oval form in a lathe.

The *lathe* is compoſed of two wooden cheeks, or ſides, parallel to the horizon, having a groove or opening between; perpendicular to theſe are two other pieces, called *puppets*, made to ſlide between the cheeks, and to be fixed down at any point at pleaſure.

Theſe have two points, between which the piece to be turned is ſuſtained; the piece is turned round, backwards and forwards, by means of a ſtring put round it, and faſtened above to the end of a pliable pole, and underneath to a treddle or board, moved with the foot: there is alſo a reſt which bears up the tool, and keeps it ſteady.

The invention of the *lathe* is very antient: *Diodorus Siculus* ſays, the firſt who uſed it was a grandſon of *Dedalus*, named *Talus*. *Pliny* aſcribes it to *Theodore* of *Samos*, and mentions one *Thericles*, who rendered himſelf very famous by his dexterity in managing the *lathe*. ---With this inſtrument the antients turned all kinds of vaſes, many whereof they enriched with figures and ornaments in baſſo-relievo. Thus *Virgil*,

Lenta quibus turno facili ſuperaddita vitis.

the *Greek* and *Latin* authors make frequent mention of the *lathe*; and *Cicero* calls the workmen, who uſed it, *Vaſcularii*. It was a proverb among the ancients, to ſay one thing was formed in the *lathe*, to expreſs its delicacy and juſtneſs. The ſame proverb is retained to this day among the *French*; and they ſay of a man, who is exceedingly well ſhaped, *il eſt fait au tour*.

There is a kind of wooden pulley, making a member of the *turner*'s lathe, which is called *mandrel*. Of theſe there are ſeveral kinds; as

Flat mandrels which have three or more little pegs or points, near the verge, and are uſed for turning flat boards on.

Pin mandrels, which have a long wooden ſhank to fit into a round hole made in the work to be done.

Hollow mandrels, which are hollow of themſelves, and uſed for turning hollow work.

Screw mandrels, for turning ſcrews.

The other inſtruments uſed in *turning*, are chiſſels of different kinds.

Turning is performed, by putting the ſubſtance to be turned upon two points, as an axis; and moving it about on that axis, while an edge-tool, ſet ſteady to the outſide of the ſubſtance, in a circumvolution thereof, cuts off all the parts that lie farther off the axis, and makes the outſide of that ſubſtance concentrick to the axis.

The workman ſtands, or is ſeated at his *lathe*, with his right foot on the treddle to give the motion, which muſt be very moderate and even; he places his chiſſel on a reſt, faſtened to the *lathe*, ſome diſtance from his piece which is to be worked, and a little underneath it he approaches gently his chiſſel to the piece, ſo that the edge thereof may reach it; and goes on gradually to work, without leaving any ridges; but when a piece is to be cut off quite, and when he meets with a knot, he muſt go on ſtill more gently, otherwiſe he would run the riſk of ſplitting his work, and notch his tool.

TAPESTRY.

TAPESTRY, with the needle, is done upon canvas, finer or coarſer, according to the fineneſs or coarſneſs whereof the work is intended to be; on which is drawn the deſign of the work with a *crayon*; after which, the artiſt traces ſlightly with a worſted thread, if the work is to be of wool, all the contours, then frames it and ſets himſelf to work; which work conſiſts in ſingle, double, and croſs ſtitches.

Tapeſtry on the loom, being more curious, and done with more expedition, I'll enter into a more particular detail of its manufacture; informing firſt the reader, that there are two kinds of *tapeſtry*, viz. *tapeſtry* of the *high*, and the *low-warp*; tho' the difference is rather in the manner of working, than in the work itſelf, which is in effect the ſame in both; only the loom, and conſequently the *warps*, are differently ſituated; thoſe of the *low-*

low-warp being placed flat, and parallel to the horizon; and thoſe on the contrary of the *high-warp*, erected perpendicularly.

We muſt endeavour to inform ourſelves how both kinds are work'd, and as *tapeſtry* of the *high-warp* is the moſt eſteemed, we will begin by examining the loom it is made upon, which is placed perpendicularly, and conſiſts of four principal pieces; two long planks or cheeks of wood, and two thick rollers or beams. The planks are ſet upright, and the beams acroſs them, one a-top, and the other at bottom, a foot diſtance from the ground. They have each their trunnions, by which they are ſuſpended on the planks, and are turned with bars. In each roller is a groove, from one end to the other, capable of containing a long round piece of wood, faſtened therein with hooks; its uſe is to tie the ends of the *warp* to the *warp*, which is a kind of worſted; a twiſted woollen thread is wound on the upper roller; and the work, as faſt as wove, is wound on the lower.

Within ſide the planks, which are ſeven or eight foot high, fourteen or fifteen inches broad, and three or four thick, are holes pierced from top to bottom, in which are put thick pieces of iron, with hooks at one end, ſerving to ſuſtain the coat-ſtave: theſe pieces of iron have alſo holes pierced, by putting a pin in which the ſtave is drawn nearer or ſet farther off; and thus the coats, or threads, are ſtretched or looſened at pleaſure. The coat-ſtave is about three inches diameter, and runs all the length of the loom: on this are fixed the coats or threads, which make the threads of the *warp* croſs each other. It has much the ſame effect here, as the ſpring-ſtave and treddles have in the common looms. The coats are little threads faſtened to each thread of the *warp*, with a kind of ſliding knot, which forms a ſort of march or ring. They ſerve to keep the *warp* open, for the paſſage of broaches wound with ſilks, woollen, or other matters uſed in the piece of *tapeſtry*. Laſtly, there are a number of little ſticks, of different lengths, but all about an inch diameter, which the workman keeps by him in baſkets, to ſerve to make the threads of the *warp* croſs each other, by paſſing them a-croſs; and that the threads thus croſſed, may retain their proper ſituation, a pack-thread is run along the threads above the ſtick.

The loom thus formed and mounted with its *warp*, the firſt thing the workman does, is to draw on the threads of this *warp*, the principal lines or ſtrokes of the deſign, to be repreſented on the piece of *tapeſtry*, which is done by applying cartoons, made from the painting he intends to copy, to the ſide that is to be the wrong ſide of the piece, and then with a black-lead pencil, following and tracing out the contours thereof, on the threads of the right ſide; ſo that the ſtrokes appear equally both before and behind. As to the original deſign the work is to be finiſhed by, it is hung up behind the workman, and wound on a long ſtaff, from which a piece is unrolled from time to time, as the work proceeds.

Beſides the loom here deſcrib'd, are required a broach, a reed, and an iron needle, for working the ſilk, or wool of the hoof within the threads of the *warp*. The broach is of hard wood, 7 or 8 inches long, and two-thirds of an inch thick, ending in a point, with a little handle, and ſerves as a ſhuttle, the ſilk, woollen, gold or ſilver to be uſed in the work, being wound on it. The reed or comb, is alſo of wood, eight or nine inches long, and an inch thick at the back; whence it uſually grows leſs and leſs, to the extremity of the teeth, which are more or leſs apart, according to the great or leſs degree of fineneſs of the intended work. Laſtly, the needle is in form of a common needle, only bigger and longer. Its uſe is to preſs cloſe the wool and ſilks, when there is any line or colour that does not ſit well.

All things being prepared for the work, and the workman ready to begin, he places himſelf on the wrong ſide the piece, with his back towards the deſign; ſo that he works as it were blind-fold, ſeeing nothing of what he does, and being obliged to quit his poſt, and go to the other ſide the loom, whenever he will view and examine the piece, to correct it with his preſſing needle. To put any ſilk, woollen, *&c.* in the *warp*, he firſt turns and looks at his deſign; then taking a broach full of the proper colour, he places it among the threads of the *warp*, which he brings acroſs each other with his fingers, by means of the coats or threads faſtened to the ſtaff, which he repeats every time he changes his colours. The ſilk or wool being placed, he beats it with his reed or comb, and when he has thus wrought in ſeveral rows over each other, he goes to ſee the effect they have, in order to reform the contours with his needle, if there be occaſion. As the work advances, they roll it up on the lower beam, and unroll as much *warp* from the upper beam as ſuffices them to continue the piece; the like they do of the deſign behind them. When the pieces are wide, ſeveral workmen may be employed at once.

The *high-warp tapeſtry* goes on much ſlower than the *low-warp*, and takes almoſt double the time and trouble. And that all the difference the eye can obſerve between the two kinds,

kinds, conſiſts in this, that in the *low-warp* there is a red fillet, about one-twelfth of an inch broad, running on each ſide from top to bottom, which is wanting in the *high-warp*.

The loom, or frame, on which the *low-warp tapeſtry* is worked, is much like that of the weavers: the principal parts thereof are two ſtrong pieces of wood, forming the ſides of the loom, and bearing a beam or roller at each end: they are ſuſtained at bottom with other ſtrong pieces of wood, in manner of treſſels; and to keep them the firmer, are likewiſe faſtened to the floor with a kind of buttreſſes, which prevent any ſhaking, though there are ſometimes four or five workmen leaning on the fore-beam at once. The rollers have each their trunnions, by which they are ſuſtained: they are turned by large iron pins, three foot long. Along each beam runs a groove, wherein is placed the wich, a piece of wood of about two inches diameter, and almoſt the length of the roller: this piece fills the groove entirely, and is faſtened therein from ſpace to ſpace by wooden pins; to the two wiches are faſtened the two extremities of the *warp*, which is wound on the further roller; and the work, as it advances, on the nearer. Acroſs the two ſides, almoſt in the middle of the loom, paſſes a wooden bar, which ſuſtains little pieces of wood, not unlike the beam of a ballance: to theſe pieces are faſtened ſtrings, which bear certain ſpring-ſtaves, wherewith the workman, by means of two treddles under the loom whereon he ſets his feet, gives a motion to the coats, and makes the threads of the *warp* riſe and fall alternately. Each loom has more or fewer of theſe ſpring-ſtaves, and each ſtave more or fewer coats, as the *tapeſtry* conſiſts of more or fewer threads.

The deſign or painting the workman is to follow, is placed underneath the *warp*, where it is ſuſtained, from ſpace to ſpace, with ſtrings, by which the deſign is brought nearer the *warp*.

The loom being mounted, there are two inſtruments uſed in working it, *viz.* the reed and the flute. The flute does the office of a weaver's ſhuttle: it is made of a hard poliſhed wood, three or four lines thick at the ends, and ſomewhat more in the middle, and three or four inches long. On it are wound the ſilks and other matters to be uſed as the woof of the *tapeſtry*. The comb, or reed, is of wood or ivory; it has uſually teeth on both ſides; it is about an inch thick in the middle, but diminiſhes each way to the extremity of the teeth: it ſerves to beat the threads of the woof cloſe to each other, as faſt as the workman has paſſed and placed them with his flute among the threads of the *warp*.

The workman is ſeated on a bench before the loom, with his breaſt againſt the beam, only a cuſhion or pillow between them; and in this poſture ſeparating with his fingers the threads of the *warp*, that he may ſee the deſign underneath; and taking a flute, mounted with the proper colour, he paſſes it among the threads, after he has raiſed or lowered them, by means of the needles moving the ſpring-ſtaves and coats. Laſtly, to preſs and cloſe the threads of the ſilk or yarn, *&c.* thus placed, he ſtrikes each courſe (*i. e.* what the flute leaves in its paſſing and coming back again) with the reed.

The *low-warp* has this in common with the *high-warp*, that all is wrought on the wrong ſide; ſo that the workman cannot ſee the right ſide of his *tapeſtry* till the piece be finiſhed and taken off his loom.

Note, alſo, That the uſual widths of *tapeſtries*, are from two ells to three ells and a half, *Paris* meaſure.

The invention of tapeſtry ſeems to have come from the *Levant*; and what makes this the more probable is, that formerly the workmen concerned herein were called, at leaſt in *France*, *Sarazins* or *Sarazineis*. It is ſuppoſed that the *Engliſh* and *Flemiſh*, who were the firſt that excelled therein, might bring the art with them from ſome of the Croiſades, or expeditions againſt the *Sarazens*. Be this as it will, it is certain thoſe two nations, particularly the *Engliſh*, were the firſt who ſet on foot this noble and rich manufacture in *Europe*; now one of the fineſt ornaments of palaces, baſiliſks, churches, *&c.* Hence if they be not allow'd the inventors, they have, at leaſt, the glory of being the reſtorers of ſo curious and admirable an art, as gives a kind of life to wools and ſilks, in no reſpect inferior to the painting of the beſt maſters.

It was late before the *French* applied themſelves to *tapeſtry*: the firſt eſtabliſhment of that kind was under *Henry* IV. in the year 1607, in the *Fauxbourg St. Marcel*; but this fell at the death of that Prince. Under *Lewis* XIV. the manufacture was retrieved by the care and addreſs of the great M. *Colbert*, at the *Goblins*, (at preſent called the *Hotel Royal of the Goblins*, in conſequence of an edict of *Lewis* XIV.) where during his ſuperintendency, and that of his ſucceſſor, M. *de Louvois*, the making of *tapeſtry* has been practiſed to a degree of perfection, which ſurpaſſes what was antiently done by the *Flemiſh*. The battles of *Alexander*, the four ſeaſons, the four elements, the King's palaces, and

and a ſeries of the principal actions of the life of *Lewis* XIV. from the time of his marriage to the firſt conqueſt of *Franche Comté*, done from the deſigns of M. *le Brun*, director of the manufactory of the *Goblins*, are maſter-pieces in their kind. The manufacture of the *tapeſtry* of the *Goblins* ſubſiſts yet, with the ſame glory, and produces by intervals ſome very extraordinary pieces, not at all inferior to what was done under the direction of *le Brun*. The late Czar of *Muſcovy*, *Peter the Great*, was preſented while at *Paris*, in 1718, by the preſent King, *Lewis* XV. with a ſet of hangings, made at the *Goblins*, eſteemed at 20 or 25000 *l.* ſterling.

VARNISH.

VARNISH, or VERNISH, a thick, viſcid, ſhining liquor, uſed by painters, gilders, and various other artificers, to give a gloſs and luſtre to their works; as alſo to defend them from the weather, duſt, *&c.*

There are ſeveral kinds of varniſhes in uſe; as the ſiccative or drying varniſh, made of oil of aſpin, turpentine, and ſandarach melted together. White varniſh, called alſo Venetian varniſh, made of oil of turpentine, fine turpentine, and maſtic. Spirit of wine varniſh, made of ſandarach, white amber, gum elemi, and maſtic; ſerving to gild leather, picture-frames, *&c.* withal. Alſo the gilt-varniſh, china-varniſh, common varniſh, *&c.*

1. To make the white varniſh: take gum ſandarach, of the cleareſt and whiteſt ſort, eight ounces; gum maſtic, of the cleareſt ſort, half an ounce; of ſarcocolla, the whiteſt, three quarters of an ounce; Venice turpentine, an ounce and a half; benzoin, the cleareſt, one quarter of an ounce; white roſin, one quarter of an ounce; gum animæ three quarters of an ounce: let all theſe be diſſolved, and mixed in the manner following:

Put the ſarcocolla and roſin into a little more ſpirits than will cover them, to diſſolve; then add the benzoin, gum animæ, and Venice turpentine, into either a glaſs or glazed earthen veſſel, and pour on as much ſpirits as will cover them an inch; then put the gum maſtic into a glaſs or glazed veſſel, and pour ſtrong ſpirits upon it, covering it alſo about an inch thick, to diſſolve it rightly; then put your gum elemi in a diſtinct veſſel as before, and cover it with ſpirits to diſſolve.

For this purpoſe, you need only break the roſin a little, and powder the gum animæ, ſarcocolla, and benzoin.

Let all ſtand three or four days to diſſolve, ſhaking the glaſſes, *&c.* two or three times a day, and afterwards put them all together into a glazed veſſel, ſtirring them well, and ſtrain the liquor and gums gently, beginning with the gums, thro' a linen cloth.

Then put it into a bottle, and let it ſtand a week before you uſe it, and pour off as much of the clear only, as you think ſufficient for preſent uſe.

2. The white amber-varniſh is thus made, according to Mr. Boyle: take white roſin four drams, melt it over the fire in a clean glazed pipkin; then put into it two ounces of the whiteſt amber you can get, finely powdered. This is to be put in, by a little and a little, gradually, keeping it ſtirring all the while with a ſmall ſtick, over a gentle fire, till it diſſolves, pouring in now and then a little oil of turpentine, as you find it growing ſtiff; and continue ſo to do till all your amber is melted.

But great care muſt be taken not to ſet the houſe on fire, for the very vapours of the oil of turpentine will take fire by heat only; but if it ſhould happen ſo to do, immediately put a flat board or wet blanket over the fiery pot, and by keeping the air from it, you will put it out, or ſuffocate it.

Therefore it will be beſt to melt the roſin, in a glaſs of a cylindrick figure, in a bed of hot ſand, after the glaſs has been well annealed, or warmed by degrees in the ſand, under which you muſt keep a gentle fire.

When the varniſh has been thus made, pour it into a coarſe linen bag, and preſs it between two hot boards of oak or flat plates of iron; after which it may be uſed with any colours in painting, and alſo for varniſhing them over when painted.

But for covering gold, you muſt uſe the following varniſh: mean time, it is to be obſerved, that when you have varniſhed with white varniſh, you may put the things varniſhed into a declining oven, which will harden the varniſh.

3. A hard varniſh, that will bear the muffle, may be thus made: take of colophony, an ounce; ſet it over the fire in a well-glazed earthen veſſel, till

till it is melted; then by little and little, ſtrew in two ounces of powder of amber, keeping it ſtirring all the while with a ſtick; and when you perceive it to begin to harden or reſiſt the ſtick, then put in a little turpentine oil, which will thin and ſoften it immediately; then put in two ounces of gum copal, finely powdered, ſprinkling it in as you did the amber, now and then pouring in a little oil of turpentine; and when it is done, ſtrain it as before directed.

This is proper to varniſh over gold; and the things done with it muſt be ſet into a declining oven, three or four days ſucceſſively, and then it will reſiſt even the fire itſelf.

4. To make a varniſh for braſs, that will cauſe it to look like gold. Take two quarts of ſpirit of wine, and put it into a retort glaſs; then add to it an ounce of gamboge, two ounces of lacca, and two ounces of maſtic; ſet this in a ſand-heat for ſix days, or elſe near a fire, or you may put the body of the bolt head frequently into warm water, and ſhake it two or three times a day; then ſet it over a pan of warm ſaw-duſt. But before this varniſh is laid over the metal, let it be well cleaned.

This is a good varniſh to mix with any colours that incline to red, and the amber-varniſh for mixing with thoſe that are pale.

5. To make a varniſh for gold, or metals made in imitation of gold. Take colophony, and, having melted it, put in two ounces of amber finely powdered, and ſome ſpirit of turpentine, and, as the amber thickens, keep it well ſtirring; then put in an ounce of gum elemi, well pulverized, and more ſpirit of turpentine; conſtantly ſtirring the liquor till all is well mixed and incorporated: but take care, however, to uſe as little turpentine as you can, becauſe, the thicker the varniſh is made, the harder it will be. Let this be done over a ſand-heat, in an open glaſs; then ſtrain it, as is directed for the preceding varniſh. This varniſh is to be uſed alone, firſt warming the veſſels made of paper-paſte; and lay it on with a painting-bruſh before the fire, but not too near, leaſt the fire raiſe it into bliſters. After this has been done, harden it three ſeveral times in ovens; firſt with a ſlack heat, the next with a warmer, and the third with a very hot one; and the veſſels will look like poliſhed gold.

And as for ſuch veſſels, *&c.* as ſhall be made with ſaw-duſt and gums, the varniſh may be made of the ſame ingredients as above-mentioned, except the gum-elemi; and this will dry in the ſun, or in a gentle warmth.

6. To make a varniſh for any thing covered with leaf-ſilver. Firſt paint the thing over with ſize, and ground chalk or whiting; let them ſtand till they are thoroughly dry, and then do them over with very good gold-ſize, of a bright colour (for there is much difference in the colour of it; ſome being yellow, and others almoſt white; the firſt is moſt proper for gold, and the laſt for ſilver). When this ſize is ſo dry as that it will juſt ſtick a little to the touch, lay on the leaf ſilver, and cloſe it well to the ſize.

7. To make a varniſh for ſilver. Melt in a well glazed pipkin, ſome fine turpentine, and put in three ounces of white amber, finely powdered (more or leſs, according to the quantity your work will require) put it in by little and little, keeping it continually ſtirring, adding by degrees ſome ſpirit of turpentine, till all the amber is diſſolved; and then add to it an ounce of ſarcocolla well beaten, and an ounce of gum elemi well levigated, adding now and then a little ſpirit of turpentine, till all is diſſolved: do this over a gentle fire, and keep it conſtantly ſtirring.

This varniſh will be as white and ſtrong as the former; and is to be uſed warm, and hardened by degrees in an oven, as varniſhed gold, whereby it will look like poliſhed ſilver.

Laying on of VARNISHES. 1. If you varniſh wood, let your wood be very ſmooth, cloſe-grained, free from greaſe, and rubbed with ruſhes. 2. Lay on your colours as ſmooth as poſſible; and, if the varniſh has any bliſters in it, take them off by a poliſh with ruſhes. 3. While you are varniſhing, keep your work warm, but not too hot. 4. In laying on your varniſh, begin in the middle, and ſtroke the bruſh to the outſide; then to another extreme part, and ſo on till all be covered; for if you begin at the edges, the bruſh will leave blots there, and make the work unequal. 5. In fine works uſe the fineſt tripoli in poliſhing: do not poliſh it at one time only; but, after the firſt time, let it dry for two or three days, and poliſh it again for the laſt time. 6. In the firſt poliſhing you muſt uſe a good deal of tripoli, but in the next a very little will ſerve; when you have done, waſh off your tripoli with a ſponge and water: dry the varniſh with a dry linen rag; and clear the work, if a white ground, with oil and whiting; or, if black, with oil and lamp-black.

VARNISH alſo ſignifies a ſort of ſhining coat, wherewith potter's ware, delft ware, china ware, *&c.* are covered, which gives them a ſmoothneſs and luſtre. Melted lead is generally uſed for the firſt, and ſmalt for the ſecond. See the article GLAZING.

VARNISH, among medaliſts, ſignifies the colours antique medals have acquired in the earth.

The beauty which nature alone is able to give to medals, and art has never yet attained to counterfeit,

terfeit, enhances the value of them; that is, the colour, which certain ſoils, in which they have a long time lain, tinges the metals withal; ſome of which are blue, almoſt as beautiful as the turquoiſe; others with an inimitable vermilion colour; others with a certain ſhining poliſhed brown, vaſtly finer than braſil figures.

The moſt uſual varniſh is a beautiful green, which hangs to the fineſt ſtrokes without effacing them, more accurately than the fineſt enamel does on metals.

No metal but braſs is ſuſceptible of this; for the green ruſt that gathers on ſilver always ſpoils it, and it muſt be got off with vinegar or lemon juice.

Falſifiers of metals have a falſe or modern varniſh, which they uſe on their counterfeits, to give them the appearance, or air, of being antique. But this may be diſcovered by its ſoftneſs, it being ſofter than the natural varniſh, which is as hard as the metal itſelf.

Some depoſite their ſpurious metals in the earth for a conſiderable time, by which means they contract a ſort of varniſh, which may impoſe upon the leſs knowing; others uſe ſal armoniac, and others burnt paper.

VENEERING.

VENEERING, VANEERING, or FINEERING, a kind of marquetry, or inlaying, whereby ſeveral thin ſlices or leaves of fine woods, of different kinds, are applied and faſtened on a ground of ſome common wood.

There are two kinds of inlaying; the one, which is the moſt common and more ordinary, goes no farther than the making of compartments of different woods; the other requires much more art, in repreſenting flowers, birds, and the like figures.

The firſt kind is properly called veneering; the latter is more properly called marquetry.

The wood uſed in veneering is firſt ſawed out into ſlices or leaves about a line in thickneſs, *i. e.* the twelfth part of an inch. In order to ſaw them, the blocks or planks are placed upright, in a kind of ſawing-preſs. See SAWING-MILL.

Theſe ſlices are afterwards cut into narrow ſlips, and faſhioned divers ways, according to the deſign propoſed; then the joints having been exactly and nicely adjuſted, and the pieces brought down to their proper thickneſs, with ſeveral planes for the purpoſe, they are glued down on a ground or block, with good ſtrong Engliſh glue.

The pieces being thus jointed and glued, the work, if ſmall, is put in a preſs; if large, 'tis laid on a bench covered with a board, and preſſed down with poles or pieces of wood, one end of which reaches to the cieling of the room, and the other bears on the board.

When the glue is thoroughly dry, it is taken out of the preſs and finiſhed; firſt with little planes, then with divers ſcrapers, ſome of which reſemble raſps, which take off the dents, &c. left by the planes.

After it has been ſufficiently ſcraped, they poliſh it with the ſkin of a ſea-dog, wax and a bruſh, or poliſher of ſhave-graſs; which is the laſt operation.

VINEGAR.

VINEGAR is an acid penetrating liquor, prepared from wine, cyder, beer, &c. of conſiderable uſe both as a medicine and ſauce.

The proceſs of turning vegetable matters to vinegar, is thus delivered by Dr. Shaw: take the ſkins of raiſins, after they have been uſed in making wine; and pour three or four times their own quantity of boiling water upon them, ſo as to make a thin aqueous mixture. Then ſet the containing caſk, looſely covered, in a warmer place than is uſed for vinous fermentation; and the liquor, in a few weeks time, will become a clear and ſound vinegar; which being drawn off from its ſediment, and preſerved in another caſk, well ſtopped down, will continue perfect, and fit for uſe.

This experiment ſhews us a cheap and ready way of making vinegar from refuſe materials; ſuch as the huſks of grapes, decayed raiſins, the lees of wine, grounds of ale, beer, &c. which are frequently thrown away as uſeleſs. Thus, in many wine-countries, the marc, rape, or dry preſſing of grapes are thrown in heaps, and ſuffered to putrify

trify unregarded; though capable of affording as good vinegar, as the wine itſelf. In ſome places they bury copper-plates in theſe huſks, in order to make verdigreaſe; but this practice ſeems chiefly confined to the ſouthern parts of France. Our preſent experiment ſhews us how to convert them to another uſe; and the direction extends to all the matters that have once undergone, or are fit to undergo a vinous fermentation, for that all ſuch matters will afford vinegar. Thus all our ſummer-fruits in England, even blackberries; all the refuſe waſhings of a ſugar-houſe, cyder-preſſings, or the like, will make vinegar, by means of water, the open air, and warmth.

The whole proceſs, whereby this change is effected, deſerves to be attentively conſidered. And, firſt, the liquor to be thus changed, being kept warmer than in vinous fermentation, it, in a few days, begins to grow thick or turbid; and without throwing up bubbles, or making any conſiderable tumult, as happens in vinous fermentation, depoſits a copious ſediment. The effect of this ſeparation begins to appear firſt on the ſurface of the liquor, which gathers a white ſkin, that daily increaſes in thickneſs, till at length it becomes like leather; and now, if continued longer in this ſtate, the ſkin turns blue, or green, and would at laſt grow ſolid, and putrify: therefore in keeping down this ſkin as it grows, and thruſting it gently down to the bottom of the veſſel, conſiſts much of the art of vinegar-making, eſpecially from malt.

Method of making cyder-VINEGAR. The cyder (the meaneſt of which will ſerve the purpoſe) is firſt to be drawn off fine into another veſſel, and a quantity of the muſt, or pouz of apples, to be added: the whole is ſet in the ſun, if there be a conveniency for the purpoſe; and, at a week or nine days end, it may be drawn off.

Method of making beer-VINEGAR. Take a middling ſort of beer, indifferently well hopped; into which, when it has worked well, and is grown fine, put ſome rape, or huſks of grapes, uſually brought home for that purpoſe: maſh them together in a tub; then, letting the rape ſettle, draw off the liquid part, put it into a caſk, and ſet it in the ſun as hot as may be; the bung being only covered with a tile or ſlate ſtone: and in about thirty or forty days, it will become a good vinegar, and may paſs in uſe as well as that made of wine, if it be refined and kept from turning muſty.

Or thus: to every gallon of ſpring-water, add three pounds of Malaga-raiſins; which put into an earthen jar, and place them where they may have the hotteſt ſun from May till Michaelmas: then, preſſing all well, turn the liquor up in a very ſtrong iron-hooped veſſel, to prevent its burſting: it will appear very thick and muddy, when newly preſſed; but will refine in the veſſel, and be as clear as wine. Thus let it remain untouched for three months, before it be drawn off, and it will prove excellent vinegar.

Method of making wine-VINEGAR. Any ſort of vinous liquor, being mixed with its own fæces, flowers, or ferment, and its tartar firſt reduced to powder; or elſe with the acid and auſtere ſtalks of the vegetable from whence the wine was obtained, which hold a large proportion of tartar: and the whole being kept frequently ſtirring in a veſſel which has formerly held vinegar, or ſet in a warm place full of the ſteams of the ſame, will begin to ferment a-new, conceive heat, grow ſour by degrees, and ſoon after turn into vinegar.

The remote ſubjects of acetous fermentation are the ſame with thoſe of vinous; but the immediate ſubjects of it are all kinds of vegetable juices, after they have once undergone that fermentation which reduces them to wine: for it is abſolutely impoſſible to make vinegar of muſt, the crude juice of grapes, or other ripe fruits, without the previous aſſiſtance of vinous fermentation.

The proper ferments for this operation, whereby vinegar is prepared, are, 1. The fæces of all acid wines. 2. The lees of vinegar. 3. Pulveriſed tartar; eſpecially that of rheniſh wine, or the cream or cryſtals thereof. 4. Vinegar itſelf. 5. A wooden veſſel, well drenched with vinegar, or one that has been long employed to contain it. 6. Wine that has often been mixed with its own fæces. 7. The twigs of vines, and the ſtalks of grapes, currants, cherries, or other vegetables of an acid auſtere taſte. 8. Bakers leaven after it is turned acid. 9. All manner of ferments, compounded of thoſe already mentioned.

The French uſe a method of making vinegar different from that above deſcribed. They take two very large open veſſels, the larger the better, open at the top; in each whereof they place a wooden grate, within a foot of the bottom: upon theſe grates, they firſt lay twigs, or cuttings of vines, and afterwards the ſtalks of the branches, without the grapes themſelves, or their ſtones, till the whole pile reaches within a foot of the brim of the veſſels: then they fill one of theſe veſſels with wine to the very top, and half fill the other; and with liquor drawn out of the full veſſel, fill up that which was only half full before; daily repeating the ſame operation, and pouring the liquor back from one veſſel to the other; ſo that each of them is full, and half full, by turns.

When this proceſs has been continued for two or three days, a degree of heat will ariſe in the veſſel, which is then but half full, and increaſe

for

for ſeveral days ſucceſſively, without any appearance of the like in the veſſel which happens to be full during thoſe days; the liquor whereof will ſtill remain cool: and as ſoon as the heat ceaſes in the veſſel that is half full, the vinegar is prepared: which, in the ſummer, happens on the fourteen or fifteenth day from the beginning; but in the winter, the fermentation proceeds much ſlower: ſo that they are obliged to forward it by artificial warmth, or the uſe of ſtoves.

When the weather is exceeding hot, the liquor ought to be poured off from the full veſſel into the other twice a day: otherwiſe, the liquor would be over-heated, and the fermentation prove too ſtrong; whence the ſpirituous parts would fly away, and leave a vapid wine, inſtead of vinegar, behind.

The full veſſel is always to be left open at the top, but the mouth of the other muſt be cloſed with a cover of wood, in order the better to keep down and fix the ſpirit in the body of the liquor; for otherwiſe it might eaſily fly off in the heat of fermentation. The veſſel that is only half full ſeems to grow hot, rather than the other, becauſe it contains a much greater quantity of the vine twigs and ſtalks, than that, in proportion to the liquor; above which the pile, riſing to a conſiderable height, conceives heat the more, and ſo conveys it to the wine below.

Vinegar is a medicine of excellent uſe in all kinds of inflammatory and putrid diſorders, either internal or external: in ardent, bilious fevers, peſtilential, and other malignant diſtempers, it is recommended by Boerhaave as one of the moſt certain ſudorifics. Weakneſs, fainting, vomiting, hyſterical and hypochondriacal complaints have alſo been frequently relieved by vinegar applied to the mouth and noſe, or received into the ſtomach. Diſtilled vinegar has the ſame virtues, only in a ſtronger degree.

USURY.

USURY, in the general, denotes a gain or profit which a perſon makes of his money, by lending the ſame; or it is an increaſe of the principal, exacted for the loan thereof; or the price a borrower gives for the uſe of a ſum credited to him by the lender, called, alſo, intereſt; and, in ſome antient ſtatutes, dry exchange. See the article EXCHANGE.

The word uſury is generally taken in an evil ſenſe, *viz.* for an unlawful profit which a perſon makes of his money; in which ſenſe it is, that uſury is forbidden by the civil and eccleſiaſtical, and even by the law of nature.

By ſtat. 12. Ann. c. 16. which is called The Statute againſt Exceſſive Uſury, it is ordained, that no perſon ſhall take, for the loan of any money or other thing, above the value of five pounds for the forbearance of one hundred pounds for a year; and ſo in proportion for a greater or leſſer ſum: and it is declared, that all bonds, contracts, and aſſurances, made for payment of any principal ſum to be lent on uſury, above that rate, ſhall be void; and that whoſoever ſhall take, accept, or receive, by way of corrupt bargain, loan, *&c.* a greater intereſt than that laſt above-mentioned, ſhall forfeit treble the value of the money lent; and alſo, that ſcriveners, ſolicitors, and drivers of bargains, ſhall not take or receive above five ſhillings for the procuring the loan of one hundred pounds for one year, on pain of forfeiting twenty pounds, *&c.*

There can be no uſury without a loan, between which and a bargain the court has diſtinguiſhed: and though a perſon is to pay double the ſum borrowed, *&c.* by way of penalty, for the non-payment of the principal debt, it is not uſury; ſo it alſo is in reſpect to the grant of an annuity for lives, or on condition, where it exceeds the uſual intereſt, and the proportion attending contracts of this kind. Even if one ſecures a large intereſt and principal, and it is at the will of the party who is to pay; or where it happens that both the principal money and extraordinary intereſt are in hazard, or that a perſon may have leſs than his principal; as when a bond is made to pay money upon the return of a ſhip from ſea, *&c.* either of theſe caſes are not held to be uſury.

In an action brought for uſury, the ſtatute made againſt it muſt be pleaded; and in pleading an uſurious contract, as a bar to an action, the whole matter is to be ſet forth ſpecially, becauſe it lies within the party's own privity; yet on an information on the ſtatute for making ſuch contract, it is ſufficient to mention the corrupt bargain generally; becauſe matters of this kind are ſuppoſed to be privily tranſacted; and ſuch information may be brought by a ſtranger. 1 Hawk. P. C. 248. Likewiſe upon an information on the ſtatute againſt uſury, he that borrows the money may be a witneſs, after he has paid the ſame.

WEAVING.

WEAVING is the art or act of working a web of cloth, ſilk, linen, or other ſtuff, on a loom with a ſhuttle.

I'll explain all theſe different manners of *weaving*, each in order, beginning by that of weaving of cloth, which, though not the moſt curious of them all, deſerves, notwithſtanding, the firſt rank, as being the beſt and richeſt manufacture in *England*.

Cloth, as underſtood here, is a web, or a tiſſue of woollen threads, interwoven; whereof ſome called the *warp* are extended lengthways, from one end of the piece to the other; the reſt, called the *woof*, diſpoſed a-croſs the firſt, a breadthways of the piece. *Cloths* are woven on the loom, as well as linens, druggets, ſerges, camblets, *&c.* they are of various qualities, fine, coarſe, ſtrong, *&c.* Some are made of wool, and theſe of different colours; the wools being dyed and dreſs'd, are firſt ſpun, then wove; others are worked white, deſigned to be dyed in ſcarlet, black, blue, green, yellow, *&c.*

To manufacture cloth for dying, the beſt wools for the purpoſe are thoſe of *England* and *Spain*, eſpecially thoſe of *Lincolnſhire* and *Segovia*.---To uſe them to the beſt advantage; when taken out of the bales, they muſt be ſcowered by putting them into a liquor ſomewhat more than lukewarm, compoſed of three parts of fair water and one of urine; after the wool has continued long enough in the liquor to diſſolve and looſen the greaſe, it is taken out, drained, and waſhed in running water; it is known to be well ſcoured, when it feels dry to the touch, and has no ſmell but the natural ſmell of the ſheep: in this ſtate it is hung out to dry in the ſhade, the heat of the ſun being apt to make it harſh and untractable: when dry, it is beat with rods on hurdles of wood, or on ropes, to clear out the duſt and groſſer filth; the more it is thus beat and cleared, the more ſoft it becomes, and the better it ſpins.---After beating, it is well picked, to clear the reſt of the filth, that had eſcaped the rods.

It is now in a ſtate to be oiled, whereof one fourth of the weight of the wool is required, for the wool deſigned for the *woof*, and one eighth for that of the *warp*.---The wool thus oiled, is to be *carded*; which operation is performed by means of two inſtruments called *cards*, all which has a double row of long points, or teeth, ranged againſt one another, and faſtened in a wooden handle, taking up the whole breadth of the handle a top, but narrower at the end. Theſe two cards they put to heat, *i. e.* the extremity thereof, in a furnace made for the purpoſe; on the other part thereof, is a ſlit, nearer the bottom than the top, thro' which the extremity of the card is introduced, the other part thereof being ſupported by ſtones, or ſomething elſe, placed underneath; when the cards are hot enough, the carder takes out one of them, ſeats himſelf on a chair or bench, and laying the head of the card on his knees, the extremity thereof upwards, holding the handle with his left hand, he takes with the right a handful of the wool, placed near him, and lays that wool on his card, by ſtriking the card with it, which lays hold of the wool; and thus continue taking wool, and ſtriking it on the card, till it very near reaches the end which has been heated. This done, he puts again the extremity of the card, thus filled, to heat, and takes out another card, which he fills in the ſame manner; which done, he takes the firſt filled from off the fire, faſtens it to a hook made for the purpoſe, one part thereof enters the handle of the card, and the other lays hold of that part where the ſpindles are faſtened; then draws off the wool.

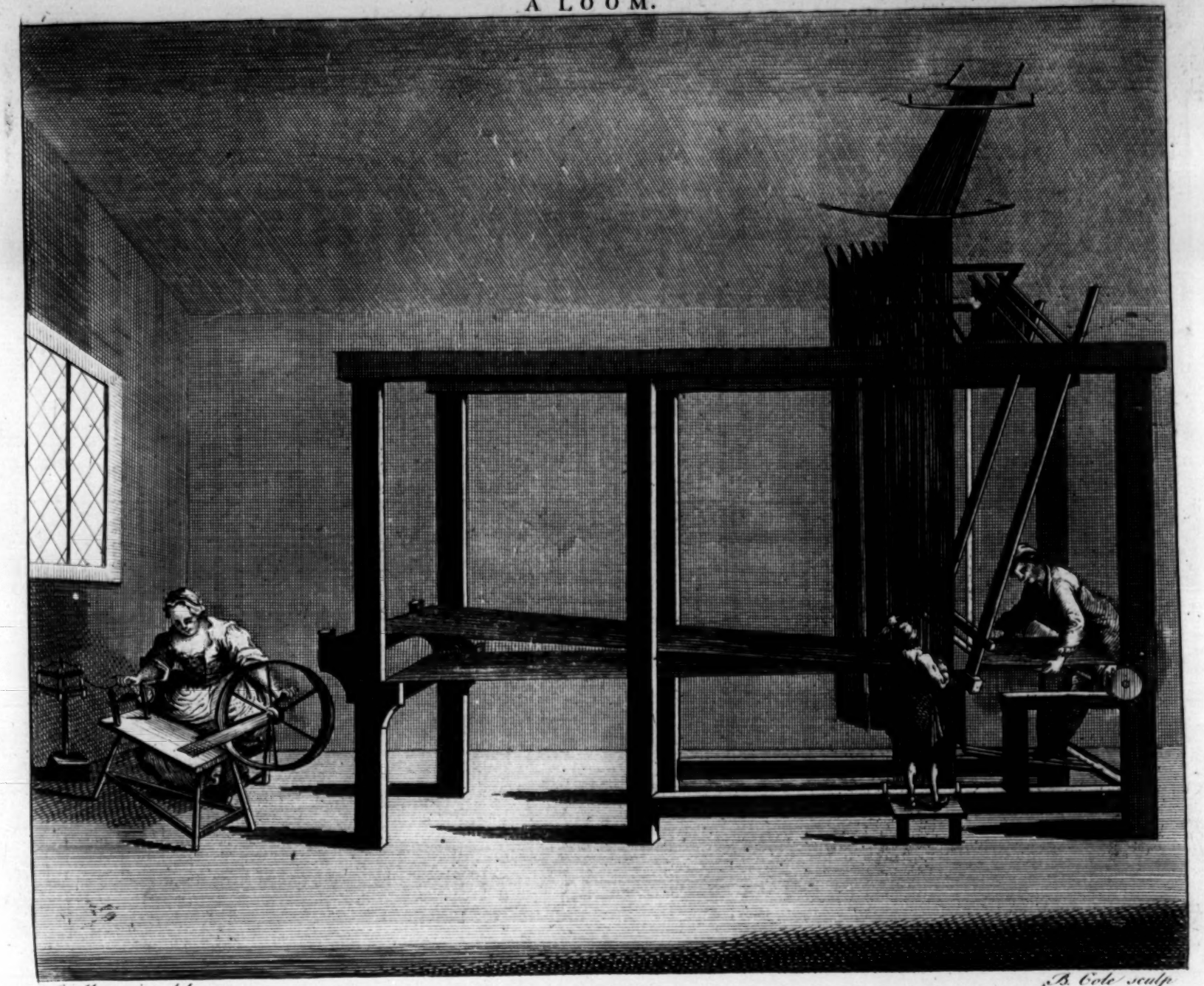
The wool thus carded, is ſpun on the wheel; obſerving to make the thread of the warps ſmaller by one third than that of the woof, and much cloſer twiſted; in order to this, the latter muſt be ſpun with the band or ſtring open, and the former with it croſſed.

The thread thus ſpun, reel'd, and made into ſkains; that deſigned for the woof is wound on *ſpools*, i. e. on little tubes, or pieces of paper, or ruſhes, ſo diſpoſed as that they may eaſily be put in the eye of the ſhuttle.---That for the warp is wound on a kind of rochets, or large wooden bobbins, to diſpoſe it for warping. When warped, it is ſtiffened with ſize, whereof that made of the ſhreds of parchment is the beſt; and when dry, it is given to the weavers, who mount it on the loom.

The warp being on the loom, the weavers, who are two to each loom, one on each ſide, tread at the ſame time alternately, on the ſame threads, i. e. now on the right ſtep, and now on the left, which raiſes and lowers the threads of the warp equally, between which they throw tranſverſly the ſhuttle,

one

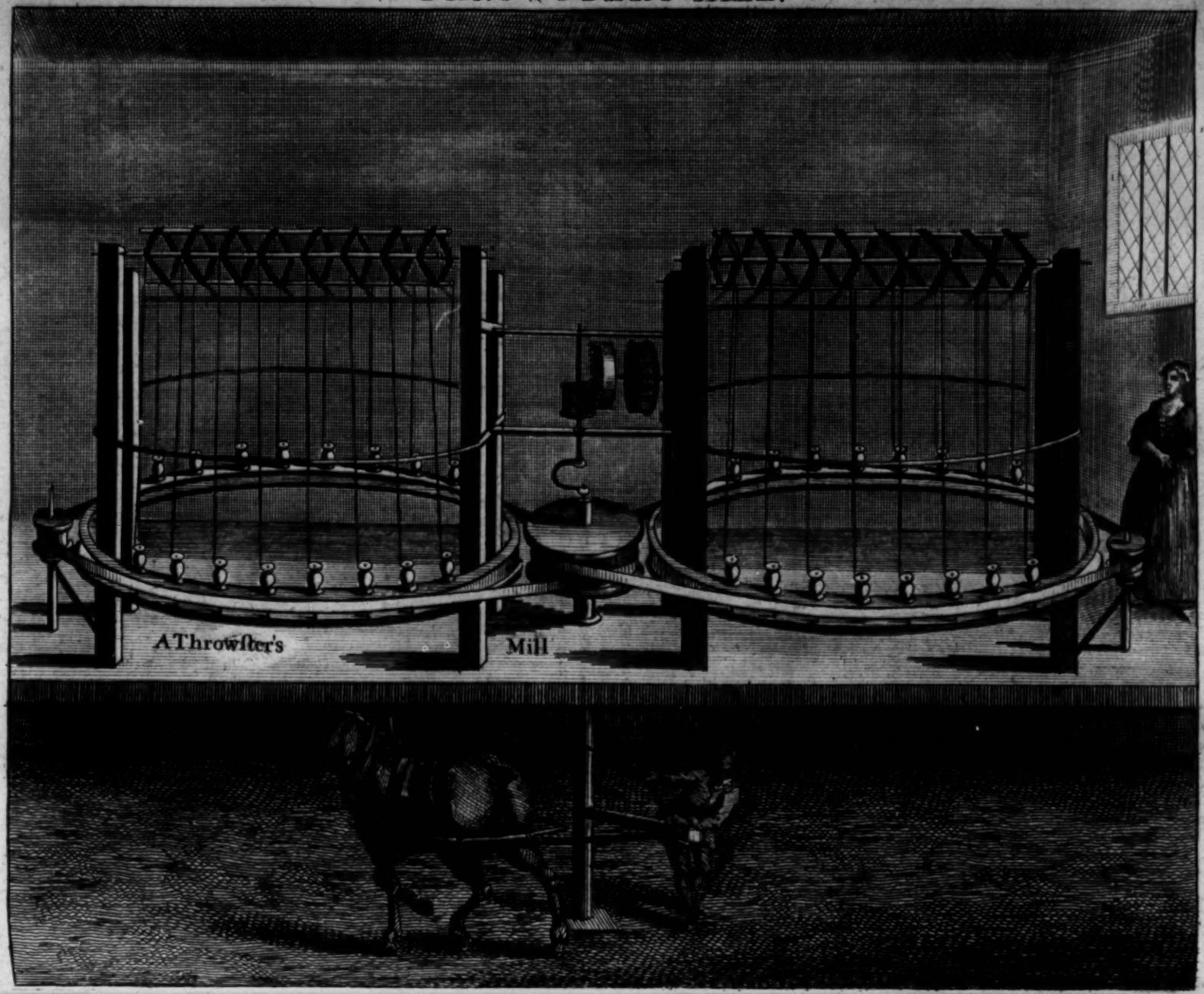
A LOOM.



T. Marvenia del *B. Cole sculp*

BRITISH
14 OCT 89
MUSEUM

THROWSTERS MILL.



one to the other; and each time that the ſhuttle is thrown, and ſo a thread of the woof inſerted within the warps, they ſtrike it conjointly with the ſame thread, wherein is faſtened the comb, or reed, between whoſe teeth the threads of the warp are paſſed; repeating the ſtroke as often as is neceſſary; in ſome cloths, no leſs than twelve or thirteen times, *viz.* ſix with the warp open, and ſeven ſhut.

It may be obſerved, that the more the threads of the woof are ſtruck againſt each other, the cloſer the cloth is; hence it becomes enabled to ſuſtain the violence of the fulling-mill, as well as of the teazle, or fulling-thiſtle, without fretting or opening.

The weavers having continued their work till the whole warp is filled with woof, the *cloth* is finiſhed; it is taken off the loom, by unrolling it from the beam whereon it had been rolled, in proportion as it was wove; and now given to be cleared of the knots, ends of thread, ſtraws, and other filth; which is done with little iron nippers.

In this condition it is carried to the fullery, to be ſcoured with urine, or a kind of potter's clay, well cleaned and ſteeped in water, put along with the *cloth* in the trough wherein it is fulled.

The *cloth* being again cleared from the earth or urine, by waſhing it in water, is returned to the former hands, to have the leſſer filth, ſmall ſtraws, and almoſt imperceptible knots taken off as before: then it is returned to the fuller, to be beat and fulled with hot water, wherein five or ſix pounds of ſoap have been diſſolved. The ſoaps moſt eſteemed for this operation is the white, eſpecially that of *Genoa*. After fulling an hour and a half, it is taken out to be ſmoothed, *i. e.* to be pulled by the liſts lengthways, to take out the wrinkles and cracks occaſioned by the force of the mallets, or peſtles falling on the cloth when in the troughs.

The ſmoothing is repeated every two hours, till the fulling be finiſhed, and the *cloth* brought to its proper breadth; after which it is waſhed in clear water, to purge it of the ſoap, and given all wet to the carders, to raiſe the hair or nap, on the right ſide, with the thiſtle, or wad, wherewith they give it two rubs or courſes, the firſt againſt the grain, the ſecond with the grain.

The *cloth* being dried, after this preparation, the cloth-worker takes it, and gives it its firſt cut, or ſheering.—This done the carders reſume it, and after wetting it, give it as many more rubs or courſes with the teazle, as the quality of the ſtuff requires; always obſerving to begin againſt the hair, and to end with it; and to begin with a ſmoother thiſtle, proceeding ſtill to a ſharper, and ſharper, as far as the ſixth degree.

After this, the *cloth* being dried, is returned to the *cloth-worker*, who ſheers it a ſecond time, and returns it to the carder; who, wetting it, gives it as many courſes as he thinks fit, dries it, and gives it back again to the cloth-worker, who after ſheering it the third and laſt time, returns it to the carders, who repeat their operation as before, 'till the hair or nap be well ranged on the ſurface of the *cloth*, from one end of the piece to the other.

It muſt be obſerved, that it is indiſpenſably neceſſary the *cloth* be wet, while in the carder's hands; in order to which it is ſprinkled from time to time with water.

The nap finiſhed, and the *cloth* dried, the cloth-worker gives it as many cuts as he thinks requiſite for the perfection of the ſtuff. It muſt alſo be obſerved, that all the ſheerings muſt be on the right ſide, except the two laſt, which muſt be on the other, and that the *cloth* cannot be too dry for ſheering.

The *cloth*, thus wove, ſcowr'd, napp'd, and ſhorne, is ſent to the dyer. When dyed it is waſhed in fair water, and the cloth-worker takes it again, wet as it is, lays the hair or nap with a bruſh on a table, and hangs it on the tenters; where it is ſtretched both in length and breadth, enough to ſmooth it, ſet it ſquare, and bring it to its proper dimenſions, without ſtraining it too much; obſerving to bruſh it a-freſh, the way of the hair, while yet a little moiſt on the tenter.

When quite dry, the *cloth* is taken off from the tenter, and bruſhed again on a table, to finiſh the laying of the nap; it is then folded, and laid cold under a preſs, to make it perfectly ſmooth and even, and to give it a little gloſs. The gloſs is given by laying a leaf of vellum or cap-paper in each plait of the piece; and over the whole a ſquare plank of wood: on which, by means of a lever, the ſcrew of a preſs is brought down with the degree of force judged neceſſary, with regard to the quality of the *cloth*. In *France*, none but ſcarlet, green, blue, *&c.* receive this laſt preparation; blacks being judged better without it.

Laſtly, the *cloth* being taken out of the *preſs*, and the papers removed, it is in a condition for ſale or uſe.

As to the manufacture of *mixt* CLOTHS, or thoſe wherein the wools are firſt dy'd, then mixed, ſpun and wove of the colours intended; the proceſs, except in what relates to the colour, is moſtly the ſame with that juſt ſpoke of.

The method of adjuſting the mixture, is firſt by making a felt or flock of the colours of the intended *cloth*, as a ſpecimen: the wool of each colour is weighed; and when the ſpecimen is to the manufacturer's mind, he mixes, for uſe, a quan-

tity in the ſame proportion, eſtimating each grain of the ſpecimen at 20 pounds weight of the ſame wool in the *cloth* to be made.

Thus, if he would mix three colours, *v. gr.* coffee-colour, feuille-mort, and pale blue, the firſt to be the prevailing colour; he weighs a quantity of each: for inſtance, 70 grains of the firſt, 25 of the ſecond, and 20 of the third, then multiply each by 20 pounds of wool, and thus gains 1400 pounds for the coffee-wool, 500 pounds for the feuille-mort, and 400 pounds for the pale blue.

The wools of the ſpecimen thus weighed, are mixed, oiled, carded, moiſtened with clear water, rubbed with black ſoap, and in this ſtate wrought a long time in the hands, till they be reduced into a piece of felt, like that uſed by hatters.

It is then rinſed in water, to purge out the oil and ſoap; and when dry, the hair or nap is carded out with the teazle; then ſhorn once again, 'till the ground appear, and the ſeveral colours be diſcernable.

Laſtly, wetting it a little, and preſſing it, he examines it well, and if he be not contented with it, makes another felt; if he be, he proceeds to mix wools; when mixed it is beat on hurdles, cleaned, oiled, carded, ſpun, wove, *&c.* as in white cloth.

The goodneſs of *cloth* conſiſts, 1. In the wool being fine and well dreſſed. 2. In its being ſpun equally; always obſerving, however, that the thread of the warp be finer, and better twiſted than that of the woof. 3. In the *cloth* being well wrought and beaten on the loom, ſo as to be every where cloſe and compact. 4. In the wool's not being finer and better at one end of the piece than in the reſt. 5. In the liſts being ſufficiently ſtrong, and of the ſame length with the ſtuff; and that they conſiſt of good matter, as wool, hair, or oſtrich feathers, or the hair of *Daniſh* dogs, which laſt is the beſt. 6. In the *cloth* being well cleared of knots and other imperfections. 7. In its being firſt well ſcour'd with good fuller's earth, then fulled with the beſt white ſoap, and waſhed out in clear water. 8. In the hair or nap being well drawn out with the teazle or thiſtle on the pole, without being too much opened. 9. In its not being ſtretched or pulled farther than is neceſſary to ſet it ſquare, and bring it to its juſt length and breadth. 10. In its being only preſſed cold.

The *Engliſh cloth* is preferred throughout all *Europe*, eſpecially the beſt ſorts to all others: though the manufacture of *Vanrobes* at *Abbeville*, in *Picardy*, is arrived to a great degree of perfection; but the *French* black *cloth* is preferred to all others for the beauty of the colour.

From *cloth* I'll paſs to CAMBLET, which is a ſtuff, ſometimes of wool, ſometimes ſilk, and ſometimes hair, eſpecially that of goats with wool or ſilk: in others the warp is ſilk and wool twiſted together, and the woof hair. *France*, *England*, *Flanders* and *Holland*, are the chief places of this manufacture; *Bruſſels* exceeds them all in the beauty and quality of its *camblets*.

There are different ſorts of *camblets*, viz. *figur'd camblets*, *water camblets* and *wove camblets*.

Figured CAMBLETS are thoſe of one colour, whereon are ſtamped various figures, flowers, foliages, *&c.* by means of hot irons, which are a kind of moulds, preſſed together with the ſtuff under a preſs. Theſe are chiefly brought from *Amiens* and *Flanders*; the commerce of theſe was antiently much more conſiderable than at preſent.

Water CAMBLETS are thoſe which, after woven, receive a certain preparation with water, and are afterwards preſſed under a hot preſs, which give them a ſmoothneſs and luſtre.

Waved CAMBLETS, are thoſe whereon waves are impreſſed, as on tabbies; by means of a calender, under which they are paſſed and repaſſed ſeveral times.

The manufacturers, *&c.* of *camblets*, are to take care they do not acquire any falſe and needleſs plaits; it being almoſt impoſſible to get them out again.

From this I'll paſs to DRUGGETS, which is a ſort of ſtuff, very thin and narrow, uſually all wool, and ſometimes half wool and half ſilk; having ſometimes the whale, but more uſually without; and woven on a worſted chain. Thoſe without the whale are wove on a loom with two treddles, after the ſame manner as linnen, camblet, *&c.*—Mr. *Savary* invented a kind of gold and ſilver *druggets*; the warp being partly gold and ſilver thread, and the woof linnen.

Next comes SERGE, which is a woollen quilted ſtuff, manufactured on a loom with four treddles, after the manner of rateens, and other ſtuffs that have whale.

In regard to the manufacture of the *London ſerges*.—For wool, the longeſt is choſen for the warp, and the ſhorteſt for the woof. Before either kind is uſed, it is firſt ſcoured, by putting it in a copper of liquor, ſomewhat more than luke-warm, compoſed of three quarts of fair water, and one of urine. After having ſtaid therein long enough to diſſolve, and take off the greaſe, *&c.* it is ſtirred briſkly with a wooden peel; taken out of the liquor, drained and waſhed in a running water; dried in the ſhade, beaten with ſticks on a wooden rack to drive out the coarſer duſt and filth; and then picked clean with the hand. Thus far prepared, it is greaſed with oil of olives, and the longeſt

longeſt part deſtined for the warp, combed in the manner mentioned under the article cloth.—To clear off the oil again the wool is put in a liquor compoſed of hot water, with ſoap melted therein: whence being taken out, wrung and dried, it is ſpun on the wheel.

As to the ſhorteſt wool intended for the woof, it is only carded on the knee with ſmall fine cards, then ſpun on the wheel, without being ſcoured of its oil.

The wool both for the warp and woof being ſpun, and the threads divided into ſkains; that of the woof is put on ſpools (unleſs it has been ſpun upon them) fit for the cavity or eye of the ſhuttle; and that for the warp wound on a kind of wooden bobbins, to fit it for warping. When warped, it is ſtiffened with a kind of ſize, uſed for the warp of cloth; and when dry, it is put on the loom.

When mounted on the loom, the workman raiſing and falling the threads (which are paſſed through a reed) by means of four treddles placed underneath the loom, which he makes to work tranſverſely equally, and alternately, one after another, with his feet, in proportion as the threads are raiſed and lowered, throws the ſhuttle a-croſs, from one ſide to the other; and each time that the ſhuttle is thrown, and the threads of the woof croſſed between thoſe of the warp, ſtrikes it with the frame to which the reed is faſtened, thro' whoſe teeth the threads of the warp paſs; and this ſtroke he repeats twice or thrice, or even more, till he judges the croſſing of the ſerge ſufficiently clod. Thus he proceeds till the warp is all filled with woof.

The *ſerge* now taken off the loom, is carried to the fuller, who fulls or ſcours it in the trough of his mill, with a kind of fat earth for the purpoſe, firſt purged of all ſtones and filth. After three or four hours ſcouring, the fuller's earth is waſhed out in fair water, brought by little and little into the trough, out of which it is taken when all the earth is cleared: then with a kind of iron pincers or plyers, they pull off all the knots, ends, ſtraws, *&c.* ſticking out on the ſurface on either ſide: then return it into the fulling trough, where it is worked with water ſomewhat more than lukewarm, with ſoap diſſolved therein for near two hours. It is then waſhed out till ſuch time as the water becomes quite clear, and there be no ſigns of ſoap left: then it is taken out of the trough, the knots, *&c.* pulled off, and then put on the tenter to dry, taking care as faſt as it dries, to ſtretch it out both in length and breadth, till it be brought to its juſt dimenſions. When half dried, it is taken off the tenter, dyed, ſheared, and preſſed.

There are various kinds of *ſerges*, denominated either from the qualities thereof, or from the places where they are wrought.---The moſt conſiderable is the *London ſerge*, now highly valued abroad, particularly in *France*, where the manufacture is carried on with good ſucceſs, under the title of *ſerge façon de Londres*.---The goodneſs of *ſerge* is known by the quilting, as that of cloths by the ſpinning.

Next comes RATEEN, which is a thick woollen ſtuff quilted, wove on a loom with four treddles, like ſerges and other ſtuffs, that have the whale or quilting. There are ſome *rateens* dreſſed and prepared like cloth; others left ſimply in hair, and others where the hair or nap is freezed.---*Rateens* are chiefly manufactered in *France*, *Holland*, and *Italy*, and are moſtly uſed in linings.

From RATEENS I'll paſs to FRIZE or FREEZE, which is a kind of woollen cloth or ſtuff for winter's wear, being frized or napt on one ſide; whence in all probability it derives its name.

Of *frizes*, ſome are croſſed, others not croſſed. The former are chiefly of *Engliſh* manufacture; the latter of *Iriſh*.

As to freezing of cloth, it is forming the nap of a cloth or ſtuff into a number of little hard burs, or prominences, covering almoſt the whole ground thereof.

Some cloths are only *freezed* on the back ſide, as black cloths; others on the right ſide, as colour'd and mix'd cloths, rateens, bays, frizes, *&c.*

Freezing may be performed two ways; one with the hand, *i. e.* by means of two workmen, who conduct a kind of plank, that ſerves as a frizing inſtrument. The other by a mill, worked either by water or a horſe; or ſometimes by men. This latter is eſteemed the better way of frizing; by reaſon the motion being uniform and regular, the little knots of the *freezing* are formed more equably, and alike. The ſtructure of this uſeful machine is as follows.

The three principal parts are, the *freezer* or *criſper*, the *freezing table*, and the *drawer* or *beam*. —The two firſt are two equal planks or boards, each about ten foot long, and fifteen inches broad; differing only in this, that the *frizing-table* is lined or covered with a kind of coarſe woollen ſtuff, or rough ſturdy nap; and that the *frizer* is incruſtated with a kind of cement, compoſed of glue, gum arabick, and yellow ſand, with a little aqua vitæ or urine. The beam, or drawer, thus called by reaſon it draws the ſtuff from between the *frizer* and *frizing-table*, is a wooden roller, beſet all over with little fine ſhort points or ends of wire, like thoſe of cards uſed in carding of wool.

Next

Next come BAYS, which is a kind of coarſe, open woollen ſtuff, having a long nap; ſometimes frized on one ſide, and ſometimes not frized, according to the uſes it is intended for.--This ſtuff is without whale, being wrought on a loom with two treddles, like flannel. The manufacture of *bays* is very conſiderable in *England*, particularly about *Colcheſter*; and in *Flanders* about *Liſle* and *Tournay*, &c.

Formerly the *French*, as well as *Italians*, were furniſhed with *bays* from *England*; but of late the *French* workmen have undertaken to counterfeit them, and ſet up manufactures of their own, and that with ſucceſs, eſpecially at *Niſmes*, *Montpelier*, &c.

The export of *bays* is very conſiderable to *Spain*, *Portugal*, and *Italy*. Their chief uſe is for linings, eſpecially in the army. The looking-glaſs makers alſo uſe them behind their glaſſes, to preſerve the tin or quickſilver; and the caſe-makers to line their caſes.

FLANEL, or FLANNEL, is next, which is a kind of ſlight, looſe, woollen ſtuff, not quilted, but very warm; compoſed of a woof and warp, and wove on a loom with two treddles, after the manner of bays, &c.

SAY, or SAYE, is a kind of ſerge, or a very light croſſed ſtuff, all wool; much uſed abroad for linings, and by the Religious for ſhirts; and in *England* the quakers for aprons, for which purpoſe it is uſually green.

There are very conſiderable manufactures hereof at *Sudbury* near *Colcheſter*; alſo at *Ypres*, *Hondſcot*, &c. in *Flanders*, &c.---Thoſe made in *England* are chiefly exported to *Portugal* and *Leghorn*.

The working of the ſeveral commodities heretofore mentioned, and of many others, is called *woollen manufactory*; which makes the principal article in the foreign and domeſtick trade of *Great Britain*; being that which furniſhes the cargoes of their veſſels, that employs their people, &c. and may be ſaid to have had its riſe in the 15th century.

Till that time the *Engliſh* wool was all ſold in the fleece, to ſuch of their neighbours as came to fetch it. Among their cuſtomers, however, the principal were the *Flemings* and *Brabanters*; and particularly the merchants of *Ghent* and *Louvain*; who took off vaſt quantities to ſupply two manufactories that had flouriſhed in theſe two cities from the 10th century; and had furniſhed the greateſt part of *Europe*, and even *England* itſelf, with all ſorts of woollen cloths, &c.---But the richneſs of the manufactories of *Ghent*, and the incredible number of hands employed therein, having ſpirited up the inhabitants to revolt divers times againſt their ſovereign, on account of certain taxes which they refuſed to pay; the ſeditions were at length puniſhed and diſperſed, and part of them took refuge in *Holland*, and the reſt in *Louvain*.

Theſe laſt, together with their art of manufacturing cloths, carried with them their ſpirit of ſedition; and it was not long ere ſeveral of them, to avoid the puniſhment they had deſerved for killing ſome of the magiſtrates, removed into *England*; where they inſtructed the *Engliſh* how to work their own wool.

This eſtabliſhment is referred to the year 1420, from which time no endeavours have been ſpared to keep the *Engliſh* wool in the kingdom.

The preſident *Thuanus* makes this epocha 100 years later; and attributes the eſtabliſhment of the *woollen manufacture* in *England* to queen *Elizabeth*, and the troubles about religion, which the ſeverity of the duke of *Alva* and the *Spaniſh* inquiſition had occaſioned and kept up ſo long in the *Low Countries*.—But what that noble author ſays, is rather to be underſtood of their perfection than their firſt eſtabliſhment; and of the ſeveral great manufactories then ſet up at *Norwich*, *Colcheſter*, *Sandwich*, *Hampton*, &c.—For in the *Engliſh* and *Flemiſh* hiſtorians, we find mention made of the manutures of *London*, long before any part of the ſeventeen provinces had attempted to throw off the *Spaniſh* yoke.

As this manufacture now ſtands, Dr. *Davenant* and Mr. *King* computes the product thereof to be eight millions *per annum*; three fourths whereof are conſumed at home, and the reſt exported.

So jealous are now the *Engliſh* of their woollens, that beſides the precautions taken to uſe all their own wool themſelves, they have added that of ſelling them themſelves, and of carrying them to the places where they are required; not admitting ſtrangers to come and buy any in *England*.

And hence the eſtabliſhment of thoſe famous magazines in *Holland*, the *Levant*, and the north, where their woollen are repoſited, to be vended by factors or commiſſioners. The magazine in *Holland* has changed place divers times; and it has been ſucceſſively at *Middleburgh*, *Delf*, *Rotterdam*, and *Dort*, where it now remains; and where all the *Germans* come to furniſh themſelves.—That for the *Levant* is at *Smyrna*; and that for the north at *Archangel*.

From the woollen manufactures I will paſs to the ſilk ones, informing ourſelves, previouſly to it, what *ſilk* is, and how many different ſorts of *ſilks* there are.

SILK is a very ſoft, fine, bright delicate thread, the

the work of an inſect called *Bombyx*, or the *ſilk-worm*.

The antients were but little acquainted with the uſe and manufacture of *ſilk*: they took it for the work of a ſort of ſpider or beetle, who ſpun it out of its entrails, and wound it with its feet about the little branches of trees.—This inſect they called *Ser*, from *Seres*, a people in *Scythia*, who kept it; whence the *ſilk* itſelf they called *ſericum*.—But the *Ser* has very little affinity with our *ſilk-worm*, *Bombyx*: the former living five years, but the latter dying annually, enveloped in a yellowiſh bag, or ball; which wound out into little threads, makes what we call *ſilk*.

It was in the iſle of *Cos* that the art of manufacturing *ſilk* was firſt invented; and *Pamphila*, daughter of *Platis*, is honoured as the inventor. The diſcovery was not long unknown to the *Romans*. *Silk* was brought them from *Serica*, where the worm was a native. But ſo far were they from profiting by the diſcovery, that they could not be induced to believe that ſo fine a thread ſhould be the work of a worm, and thereupon formed a thouſand chimerical conjectures of their own.

This temper rendered *ſilk* a very ſcarce commodity among them for many ages; it was even ſold weight for weight with gold, inſomuch that *Vopiſcus* tells us, the emperor *Aurelian* refuſed the empreſs his ſpouſe a ſuit of *ſilk*, which ſhe ſollicited of him with much earneſtneſs, merely on account of its dearneſs. At length two monks coming from the *Indies* to *Conſtantinople* in 555, brought with them great quantities of *ſilk-worms*, with inſtructions for the hatching of their eggs, rearing and feeding the worms, drawing out the *ſilk*, ſpinning and working it. Upon this manufactures were ſet up at *Athens*, *Thebes*, and *Corinth*.

About the year 1130, *Roger*, king of *Sicily*, eſtabliſhed a ſilk manufacture at *Palermo*, and another in *Calabria*, managed by workmen who were part of the plunder brought from *Athens*, *Corinth*, &c. whereof that prince made a conqueſt, in his expedition to the holy land. By degrees, *Mezeray* adds, the reſt of *Italy* and *Spain* learned from the *Sicilians* and *Calabrians*, the management of the *ſilk-worms*, and the working of *ſilk*: And at length the *French*, by right of neighbourhood, a little before the reign of *Francis* I. began to imitate them.

The great advantage the new manufacture turned to, made *James* I. king of *England*, very earneſt for its being introduced into his dominions: accordingly it was recommended ſeveral times from the throne, and in the moſt earneſt terms to plant mulberry-trees, *&c.* for the propagation of *ſilk-worms*; but unhappily without effect; though from the various experiments we meet withal in the philoſophical tranſactions and other places, it appears that the *ſilk-worm* thrives, and works as well in all reſpects in *England*, as in any other part of *Europe*.

In ten days time the *ſilk-worm* having brought its ball to its perfection, it muſt be taken down from the branches of the mulberry-tree, where it is hung. But this point requires a deal of attention; for there are ſome worms more lazy than others; and it is very dangerous waiting till they make themſelves a paſſage, which uſually happens about the 15th day of the month.

The firſt, fineſt, and ſtrongeſt balls are kept for the grain; the reſt are carefully wound: or, if it is deſired to keep them all, or if there be more than can be well wound at once, they lay them for ſome time in an oven moderately hot, or elſe expoſe them for ſeveral days ſucceſſively to the greateſt heat of the ſun, in order to kill the inſect; which, without this precaution, would not fail to open itſelf a way to go, and uſe all thoſe new wings abroad it has acquired within.

Ordinarily, they only wind the more perfect balls. Thoſe that are double, or too weak, or too coarſe, are laid aſide; not as altogether uſeleſs, but that being improper for winding, they are reſerved to be drawn out into ſkains.

The balls are of different colours; the moſt common are yellow, orange-colour, iſabella, and fleſh-colour. There are ſome alſo of a ſea-green; others of a ſulphur-colour, and others white: but there is no neceſſity for ſeparating the colours and ſhades to wind them apart; as all the colours are to be loſt in the future ſcouring and preparing of the *ſilk*.

To wind the *ſilk* from off the balls, two machines are neceſſary; the one a furnace, with its copper; the other a reel or frame to draw the *ſilk*. The winder then ſeated near the furnace, throws into the copper of water over the furnace (firſt heated and boiled to a certain degree, which cuſtom alone can teach) a handful or two of balls which have been firſt well purged of their looſe furry ſubſtance. He then ſtirs the whole very briſkly about with birchin rods, bound and cut like bruſhes; and when the heat and agitation have detached the ends of the *ſilk* off the rods, which are apt to catch on the rods, he draws them forth; and joining ten or twelve, or even fourteen of them together, he forms them into threads, according to the bigneſs required, to the work they are deſtined for: eight ends ſufficing for ribbands; and velvets, *&c.* requiring no leſs

than fourteen. The ends thus joined into two or three threads, are firſt paſſed into the holes of three iron rods, in the fore part of the reel, then upon the bobbins or pullies, and at laſt are drawn out to the reel itſelf, and there faſtened; each to an end of an arm or branch of the reel. Thus diſpoſed, the workman giving motion to the reel, by turning the handle, guides his threads, ſubſtitutes new ones when any of them break, or any of the balls are wound out; ſtrengthens them where neceſſary, by adding others; and takes away the balls worn out, or that having been pierced are full of water.

In this manner two workmen will ſpin and reel three pounds of *ſilk* in a day; which is another quicker diſpatch than is made by the ſpinning-wheel, or diſtaff. Indeed all *ſilks* cannot be ſpun and reeled after this manner; either by reaſon the balls have been perforated by the *ſilk-worms* themſelves, or becauſe they are double, or too weak to bear the water; or becauſe they are coarſe, *&c.* of all theſe together, they make a particular kind of *ſilk* called *floretta*; which being carded, or even ſpun on the diſtaff, or the wheel, in the condition it comes from the ball, makes a tolerable *ſilk*.

As to the balls, after opening them with ſciſſars, and taking out the inſects (which are of ſome uſe for the feeding of poultry) they are ſteeped three or four days in troughs, the water whereof is changed every day, to prevent their ſtinking.

When they are all well ſoftened by this ſcouring, and cleared of that gummy matter the worm had lined the inſide withal, and which renders it impenetrable to the water, and even to air itſelf, they boil them half an hour in a lye of aſhes, very clear, and well ſtrained: and after waſhing them out in the river, and drying them in the ſun, they card and ſpin them on the wheel, *&c.* and thus make another kind of *floretta*, ſomewhat inferior to the former.

The ſeveral preparations which *ſilks* undergo, to fit them to be uſed in the manufacture of ſilken ſtuffs, are *ſpinning*, *reeling*, *milling*, *bleaching*, and *dying*.

The two firſt we have already ſpoke of, as they are concerned in drawing the *ſilks* from off the balls. As to the *ſpinning* and *reeling* of *raw ſilk* off the balls, ſuch as they are brought hither from *Italy*, the *Levant*, &c. the firſt is chiefly performed on the ſpinning-wheel, and the latter, either on hand-reels, or on reels mounted on machines, which ſerve to reel ſeveral ſkains at the ſame time.

Milling, or *throwing of ſilk*, is the laſt preparation thereof before dying; ſerving to twiſt it more or leſs, according to the work it is intended for.

To prepare the *ſilk* for milling, they are put in water, incloſed between two linnen cloths.—The mill is a ſquare machine, compoſed of ſeveral pieces of wood mortified in each other, ſo as to form a kind of large cage, in the center whereof are two wheels, placed parallel over each other, whoſe axis bears on two poſts. When the machine is ſimple, a ſingle man turns thoſe wheels by means of a little cogg, in which they catch, and a large handle.

The wheels put in motion by the handle, communicate their motion to eight windles or reels, or even more, according to the largeneſs of the machine; the flights or arms whereof the ſilk is wound, from off two rows of bobbins placed on each ſide the machine, each row at the height of the two wheels in the center. Theſe bobbins have their motion by means of leathern thongs, which beat on little cylinders of wood that ſupport them, and turn at length on the two wheels at the center, ſo that the *ſilk* on each bobbin twiſts as it winds and forms its ſeparate ſkain.

The ſmalleſt wheel moves two hundred of theſe bobbins, over which a ſingle perſon is ſufficient to inſpect, to put new bobbins or pools in lieu of thoſe diſcharged of their ſilk, and to knot the ends when they break.

For white ſtuffs the *ſilk* is bleached, which is done while it is yet raw, by putting it in a thin linnen bag, and thrown into a veſſel of boiling river water, wherein ſoap has been diſſolved, then boiled two or three hours, and the bag being turned ſeveral times, taken out, beaten, and waſhed in cold water, mixed with ſoap and a little indigo: the indigo gives it the bluiſh caſt always obſerved in white ſilks. After taking it out of the ſecond veſſel it is wrung out, and all the water and ſoap expreſſed, ſhook out to untwiſt and ſeparate the threads, and hung out in the air, in a kind of ſtove made on purpoſe, wherein is burnt ſulphur, the vapour whereof gives the laſt degree of whiteneſs to the *ſilks*.

There are ſeveral ſorts of *ſilks*, viz. *raw ſilk*, *boiled ſilk*, *trowed* or *twiſted ſilk*, *ſlack ſilk*, *Eaſtern*, *French*, *Sicilian*, *Italian*, *Spaniſh*, *Turky*, *China*, *Japan*, and *Indian ſilk*.

Raw SILK, is that taken from the ball, without any coction, ſuch as is moſt, if not all, that is brought into *England* from the *Levant*.

In the French *ſilk-works*, the greateſt part of this raw ſilk paſſes for little better than a kind of fine floretta; yet, when ſpun, it makes a fine thread, and ſerves for the manufacture of ſtuffs of moderate

moderate value and luſtre. But the *raw ſilks* of the *Levant*, whence moſt of the *Engliſh* come, are exceeding fine and beautiful. — This difference ariſes hence, that in *France* the beſt balls are ſpun and wound in boiling water, and only the refuſe made into *raw ſilk:* whereas in the *Levant* there is no ſuch thing as ſpinning and winding on the fire; but the ſilks are all ſent in bales or packs, as they are drawn from off the balls: ſo that they are only diſtinguiſhed by their quality of fine, middling, and coarſe.

Boiled SILK, is that which has been boiled in water, to facilitate the ſpinning and winding. This is the fineſt of all the ſorts of ſilks manufactured in *France*, and is ſeldom uſed but in the richeſt ſtuffs; as velvets, taffaties, damaſks, brocades, *&c.*—There is alſo another kind of *boiled ſilk*, which is prepared by boiling to be milled, and which cannot receive that preparation without being firſt paſſed through hot water.—By the laws of *France*, it is prohibited to mix raw with boiled ſilk; both as ſuch a practice ſpoils the dying, and as the raw ſilk corrupts and cuts the boiled.

Thrown, or *twiſted* SILKS, are ſuch, as beſides their ſpinning and winding, have received their milling or throwing.

This they receive in a different degree, as they are paſſed oftener or ſeldomer over the mill; properly, however, *thrown ſilks* are thoſe wherein the threads are pretty thick thrown, and are twiſted ſeveral times.

Slack SILKS, are ſuch as are not twiſted, but are prepared and dyed, for tapeſtry, and other works with the needle.

Eaſtern, or *Eaſt-India* SILK, properly ſo called, is not the work of the *ſilk-worm*, but comes from a plant that produces it, in pods, much like thoſe of the cotton-tree. The matter this pod contains is extremely white, and moderately gloſſy; it ſpins eaſily, and is made into a kind of *ſilk* that enters the manufacture of ſeveral *Indian* and *Chineſe* ſtuffs.

French SILKS, are thoſe of the provinces of *Languedoc*, *Dauphiné*, *Provence*, *Avignon*, *Savoy*, and *Lyons*.—This laſt place indeed furniſhes very few *ſilks* of its own growth, but is the great ſtaple whence the merchants of *Paris*, and the other cities are to fetch them: at leaſt they are obliged to have them paſs through *Lyons*, if they bring them from elſewhere, either by land or ſea.—There are computed to enter *Lyons*, *communibus annis*, 6000 bales; the bale valued at 160 lb. weight; of which 6000 bales, there are 1400 from the *Levant*, 1600 from *Sicily*, 1500 from *Italy*, 300 from *Spain*, and 1200 from *Languedoc*, *Provence*, and *Dauphiné*.

At the time when the manufactures of *Lyons* were in the height of their proſperity, there were reckoned 18,000 looms employed in the ſilk manufacture; but ever ſince ſeveral other nations, who had no notion of thoſe manufactures, have been inſtructed in it, by the *French* who have deſerted their own country, either by a motive of religion, or on ſome other account, the number of looms has been conſiderably reduced at *Lyons*; ſo that at preſent there are not above 8000 going. Tho' there be no ſilk manufacture in any country whatever which comes near that of *Lyons*, either for the ſtrength of the ſtuffs, the beauty of the pattern, and the vivacity of the colours.—They had formerly at *Tours* 700 mills for winding and preparing the *ſilks*; 8000 looms to weave them, and 40,000 perſons employed in the preparation and manufacturing thereof; which number is alſo conſiderably reduced.

The commerce of the *ſilks* of *Sicily* is very conſiderable; and the *Florentines*, *Genoeſe*, and *Luceſe*, are the people who chiefly make it. Great quantities are yearly brought thence, eſpecially from *Meſſina*; part whereof they uſe in their own manufactures, and ſell the reſt to their neighbours the *French*, &c. with profit.—The *Italians* have this advantage, eſpecially the *Genoeſe*, over other people, that having large eſtabliſhments in the iſland, they are reputed as natives, and pay no duty for the export.—Part of the *Sicilian ſilks* are raw; the reſt ſpun and milled; of which laſt kind thoſe of *S. Lucia* and *Meſſina* are the moſt valued. The raw unwrought ſilks are always ſold for ready money; the others ſometimes in exchange for other goods. — The *ſilks* brought from *Italy* are partly wrought, and partly raw, and unwrought. *Milan*, *Parma*, *Lucca*, and *Modena*, furniſhes none but the latter kind; *Genoa* moſt of the former; *Bologna* affords both kinds.

The *Spaniſh* SILKS are all raw; and are ſpur, milled, *&c.* in *England*, according to the ſeveral works they are to be uſed in.

Turky SILKS are all raw. — One advantage the *Engliſh* ſay they have in the commerce of the *Levant* in *ſilks*, wanting in thoſe of *Sicily*, is, that the latter is confined to a particular ſeaſon of the year; whereas the former are brought at all times. They are brought from *Aleppo*, *Tripoli*, *Sayda*, from the iſles of *Cyprus*, *Candia*, &c.—But the principal place of commerce, eſpecially for the *Perſian ſilks*, is *Smyrna*. The *ſilks* are brought hither in caravans, from the month of *January* to *September*. The caravans in *January* are loaded with the fineſt *ſilks*; thoſe of *February* and *March* being indifferent ones; the reſt the coarſeſt.

They all come from the ſeveral provinces of *Perſia*, chiefly thoſe of *Quillan* and *Schiruvan*, and the city of *Schamachia*, ſituate near the edge of the *Caſpian* ſea, from which three places, a *Dutch* author aſſures us, there do not come leſs than 30,000 bales of ſilk in a year. *Ardenil*, or *Ardebil*, another city of *Perſia*, not far diſtant from theſe ſilk countries, is the place where theſe *ſilks* are laid up, and whence the caravans ſet out for *Smyrna*, *Aleppo*, and *Conſtantinople*; and it is this city, with *Schamachia*, that have always been eſteemed the center of the *ſilk* trade; which has been ſeveral times attempted to be removed from *Smyrna*, and the *Mediterranean*, in favour of *Archangel* and the *White Sea*, by carrying them acroſs *Muſcovy*, by the *Volga* and *Dwyna*, two rivers that traverſe the principal provinces of that vaſt empire.

This new courſe of the *Perſian ſilks* into *Europe*, was firſt propoſed by *Paolo Centurio*, a *Genoeſe*, to the Czar *Baſil*, under the pontificate of *Leo* X. The *French* had the ſame deſign in 1626. The duke of *Holſtein*, in 1633, ſent embaſſadors to the court of *Perſia*, purely with the ſame view: and in 1668, the Czar *Alexis Michael* attempted the thing himſelf, but was diſappointed by the rebellion of the *Coſſacks*, and the ſurprize of *Aſtracan*.

Several provinces of *China* are ſo fertile in mulberry-trees, and their climate ſo agreeable to the nature of *ſilk-worms*, that the quantity of *ſilk* here produced is incredible: the ſingle province of *Tchekiam* might ſupply all *China*, and even a great part of *Europe* with this commodity. The *ſilks* of this province are the moſt eſteemed, though thoſe of *Nanquin* and *Canton* be excellent.

The *ſilk* trade is the principal in *China*, and that which employs the moſt hands: but the *European* merchants who deal in it, eſpecially in wrought *ſilks*, are to be careful of the ſpinning, *&c.* the waſte being uſually very great.

The *ſilks* of the ſtate of the great mogul are brought almoſt wholly from *Kaſem-bazar*, a *Mediterranean* place, whence they are conveyed by a canal of 15 leagues, into the *Ganges*, by which they are forwarded 15 leagues further, to the mouth of the famous river of *Indoſtan*. The *ſilk* of *Kaſem-bazar* is yelloviſh, as are alſo thoſe of *Perſia* and *Sicily*; there being none, as we know of, naturally white, but that of *Paleſtine*. The *Indians*, however, whiten it with a lye made of the aſhes of a tree, called *Adam's fig-tree*; but as the tree is pretty ſcarce, the *Europeans* are forced to take the greateſt part of their *ſilks* in the native yellow.

Kaſem-bazar alone is computed to furniſh every year 22,000 bales of *ſilk*, each bale weighing 100 lb. The *Dutch* buy it almoſt all up, not to bring it into *Europe*, but to exchange it for other rich merchandizes, particularly bars of ſilver, *&c.*

Thus furniſhed with all ſorts of *ſilks* at our choice, we will ſet ourſelves to work, beginning by the moſt eaſy manufacture, which is that of *ribbands*.

Ribband, or *Ribbond*, is a narrow ſort of ſilk, chiefly uſed for head-ornaments, badges of chivalry, *&c.*

There are plain *ribbands* and figured *ribbands*, which are all wove in the ſame manner, the difference conſiſting only in the paſſing of the threads, agreeable to the deſign propoſed.

Next comes Taffety, or Taffaty, is a kind of fine, ſmooth, ſilken ſtuff, having uſually a remarkable luſtre or gloſs.

There are *taffaties* of all colours, ſome plain, others ſtriped with gold, ſilver, ſilk, *&c.* others chequered, others flowered, others in the *Chineſe* point, others the *Hungarian*, with various others, to which the mode or the caprice of the workman gives ſuch whimſical names, that it would be as difficult as it is uſeleſs to rehearſe them; beſides that, they ſeldom hold beyond the year wherein they firſt roſe. The old names of *taffeties*, and which ſtill ſubſiſt, are *taffeties* of *Lyons*, *Spain*, *England*, *Florence*, *Avignon*, &c.

The chief conſumption of *taffaties* is in ſummer-dreſſes for women, in linings, ſcarves, coifs, window-curtains, *&c.*

There are three things which contribute chiefly to the perfection of *taffaties*, viz. the ſilk, the water, and the fire. The ſilk is not only to be of the fineſt kind, but it muſt be worked a long time, and very much, before it is uſed. The watering, beſides that it is to be given very lightly, ſeems only intended to give that fine luſtre, by a particular property not found in all waters. Laſtly, the fire, which is paſſed under it to dry the water, has its particular manner of application, whereon the perfection of the ſtuff depends very much.

Octavio May of *Lyons* is held the firſt author of the manufacture of gloſſy *taffeties*, and tradition tells us the occaſion of it. — *Octavio*, it ſeems, going backward in the world, and not able to retrieve himſelf by the manufacture of taffeties, ſuch as where then made, was one day muſing on his misfortunes, and in muſing, chanced to chew a few hairs of ſilk which he had in his mouth. His reverie being over, the ſilk he ſpit out ſeemed to ſhine, and on that account engaged his attention. He was ſoon led to reflect on the

reaſon;

reaſon; and, after a good deal of thought, concluded that the luſtre of that ſilk muſt come, 1. From his having preſſed it between his teeth. 2. From his having wet it with his *ſaliva*, which had ſomething glutinous in it: and, 3. From its having been heated by the natural warmth of his mouth. All this he executed upon the next *taffeties* he made; and immediately acquired immenſe riches to himſelf, and to the city of *Lyons* the reputation it ſtill maintains, of giving the gloſs to *taffeties*, better than any other city in the world.

It will not, we conceive, be leſs uſeful than curious, to give here the deſcription of the engine contrived by *Octavio* to give the gloſs to *taffety*; to add the manner of applying it, and the compoſition of the water uſed therein.

The machine is much like a ſilk loom, except that inſtead of iron points, here are uſed a kind of crooked needles, to prevent the *taffety* from ſlipping: at the two extremities are two beams; on one of which is rolled the *taffety* to take the gloſs; and on the other, the ſame *taffety* as faſt as it had received it. The firſt beam is kept firm by a weight of about 200 pounds; and the other turned by means of a little lever paſſing through mortices at each end. The more the *taffety* is ſtretched, the greater luſtre it takes; care however is to be uſed it be not over-ſtretched.

Beſides this inſtrument for keeping the ſtuff ſtretched, there is another to give it the fire: this is a kind of carriage in form of a long ſquare, and the breadth of the *taffaties*. It moves on trundles, and carries a charcoal fire under the *taffety*, at the diſtance of about half a foot.

The two machines prepared, and the *taffety* mounted, the luſtre is given it by rubbing it gently with a ball, or handful of liſts of fine cloth, as it rolls from one beam to the other, the fire, at the ſame time, being carried underneath it to dry it. As ſoon as the piece has its luſtre, it is put on new beams to be ſtretched a day or two, and the oftener this laſt preparation is repeated, the more it increaſes the gloſs.

For black *taffeties*, the gloſs is given with double beer, and orange or lemon juice; but this laſt is the leaſt proper, as being apt to whiten. The proportion of theſe two liquors is a gallon of orange-juice to a pint of beer, to be boiled together to the conſiſtence of a broth. For colour'd *taffeties* they uſe gourd water diſtilled in an alembick.

Next comes SATTIN, or SATIN, which is a kind of ſilken ſtuff, very ſmooth and ſhining, the warp whereof is very fine, and ſtands out, the woof coarſer, and hid underneath; on which depends that gloſs and beauty which gives it its price. There are *ſattins* quite plain, others wrought, ſome flowered with gold or ſilk, others ſtrip'd *&c.* All the varieties in the fabrick of *ſattins* are made by uſing new warps or woofs. The fineſt *ſattins* are thoſe of *Florence* and *Genoa*; yet the *French* will not allow thoſe of *Lyons* any thing inferior thereto. The *ſattins* of *Bruges* have their warp of ſilk, and their woof of thread.

Indian ſattins, or *ſattins* of *China*, are ſilken ſtuffs, much like thoſe manufactured in *Europe*. Of theſe ſome are plain, either white, or of other colours; others worked, either with gold or ſilk, flower'd, damaſk'd, ſtrip'd, *&c.* They are moſtly valued becauſe of their cleaning and bleaching eaſily, without loſing any thing of their luſtre. In other reſpects they are inferior to thoſe of *Europe*.

Father *Le Compte* obſerves, that the *Chineſe* prepare their *ſattins* in oil, to give them the greater luſtre; but this makes the duſt liable to hang to them.

SATTINET, or SATTINADE, is a very ſlight, thin ſort of *ſattin*, chiefly uſed by the ladies for ſummer night-gowns, *&c.* and ordinarily ſtrip'd.

We'll paſs from this to *damaſk*, which is a ſort of ſilken ſtuff, having ſome parts raiſed above the ground, repreſenting flowers, or other figures.

Damaſk is properly a ſort of mohair and ſattin intermixed, in ſuch manner as that what is not ſattin on one ſide, is on the other. The elevation which the ſattin makes on one ſide is the ground on the other. The flowers have a ſattin grain, and the ground a grain of taffetas. It has its name from its being originally brought from *Damaſcus* in *Syria*.

Next comes BROCADE, which is a ſort of ſtuff or cloth of gold, ſilver, or ſilk, raiſed and enriched with flowers, foliages, or other figures, according to the fancy of the manufacturer.

Formerly the term was reſtrained to cloth wove, either wholly of gold, both woof and warp, or of ſilver, or of both together; but by degrees it came likewiſe to paſs for ſuch as had ſilk intermix'd, to fill up, and terminate the flowers of gold and ſilver.

At preſent, any ſtuff of ſilk, ſattin, or even ſimple *taffety*, when wrought and enriched with flowers, *&c.* obtains the denomination of *brocade*.

Next comes TABBY, which is a kind of coarſe taffety water'd. It is manufactured like the common taffety, excepting that it is ſtronger and thicker both in the woof and warp.

The watering is given it by means of a calender, the rolls whereof are of iron or copper, variouſly engraven, which, bearing unequally on the ſtuff, renders the ſurface thereof unequal, ſo as to reflect the rays of light differently.

MOHAIR is a kind of ſtuff, ordinarily of ſilk, both woof and warp, having its grain wove very cloſe.

There are two kinds of *mohairs*, the one ſmooth and plain, the other water'd like tabbies: the difference between the two only conſiſts in this, that the latter is calendered, the other not. There are alſo *mohairs* both plain and watered, whoſe woof is woollen, cotton or thread.

From this I'll paſs to VELVET, which is a rich kind of ſtuff, all ſilk, cover'd on the outſide with a cloſe, ſhort, fine, ſoft ſhag; the other ſide being a very ſtrong cloſe tiſſue.

The nap of ſhag, called alſo the *velveting* of this ſtuff, is formed of part of the threads of the warp, which the workman puts on a long channelled ruler or needle; and which he afterwards cuts, by drawing a ſharp ſteel tool along the channel of the needle to the end of the warp.

The principal and beſt manufactories of *velvet* are in *France* and *Italy*, particularly at *Venice*, *Milan*, *Florence*, *Genoa* and *Lucca*: there are others in *Holland*, ſet up by the *French* refugees; whereof that at *Haerlem* is the moſt conſiderable: but theſe all come ſhort (ſays an *Engliſh* author) of the beauty of thoſe of *France*; and accordingly are ſold for 10 or 15 *per cent.* leſs. There are even ſome brought from *China*, but they are the worſt of all.

There are *velvets* of various kinds, as *plain*, that is uniform and ſmooth, without either figures or ſtripes.

Figur'd VELVET, that is adorned and worked with divers figures; though the grounds be the ſame with the figures; that is the whole ſurface velveted.

Ramaged or *branched* VELVET, repreſenting long ſtalks, branches, *&c.* on a ſattin ground, which is ſometimes of the ſame colour with the *velvet*, but more uſually of a different one. Sometimes, inſtead of ſattin, they make the ground of gold and ſilver; whence the denomination of *velvets* with gold ground, *&c.*

Shorn velvet, is that wherein the threads, that make the *velveting*, have been ranged in the channelled ruler, but not cut there.

Strip'd VELVET, is that wherein there are ſtripes of divers colours running along the warp; whether thoſe ſtripes be partly *velvet*, and partly ſatin, or all *velveted*.

Cut VELVET, is that wherein the ground is a kind of taffety, or *gros de tours*, and the figures *velvet*.

Velvets are likewiſe diſtinguiſhed, with regard to their different degrees of ſtrength and goodneſs; into *velvets* of four threads, three threads, two threads, and a thread and half: the firſt are thoſe where there are eighteen threads of ſhag, or *velveting* to each tooth of the reed; and the ſecond have only ſix, and the reſt four. In general, all *velvets* both worked and cut, ſhorn and flowered, have their warp and ſhag of organſm, ſpun and twiſted, or thrown in the mill; and their woof of ſilk well boiled, *&c.* They are all of the ſame breadth.

From the ſilk manufactures, I'll paſs to the *linnen ones*.

The *linnen* MANUFACTURE borrows its name from *line*, *linum*, which is a plant with a ſlender hollow ſtem, uſually about two feet high (though I have ſeen ſome which meaſured above three feet) whoſe bark conſiſts of fibres or threads, much like thoſe of hemp; which being dreſſed and worked in due manner, makes that noble commodity *linnen-cloth*. The preparations *line* muſt undergo to fit it for ſpinning, are pulling, drying, and ſwingling; which operations are inſerted in my treatiſe of agriculture under the letter A.

Line, after it has been prepared fit for ſpinning, is called flax, of which there is different ſorts, with regard to the degrees of fineneſs; which degrees it acquir'd through the cards, which card is much like that of perriwig-makers, except that the points are longer. For if the *flax* be deſigned for fine thread, it muſt paſs through a cloſer card, than when for coarſe thread.

Flax is ſpun either with the diſtaff or the wheel, and the thread acquires its degree of fineneſs between the fingers of the operator. Of this thread the *linen-cloth* is wove on a loom, with two tredles, the warp being always coarſer than the woof. If the cloth is to be very white, the thread is bleached before it is wove; if not it is wove as it comes from off the diſtaff without any other preparation.

The fineſt of all *linnen-cloth* is commonly cambrick, becauſe wove of the fineſt thread that can be ſpun; and the beſt manufactures of this ſort of cloth are in *French Flanders*.

The *linnen-cloth*, commonly called *holland*, is next to *cambrick* for fineneſs; and there are even *Hollands* much finer than ſome *Cambricks*. This ſort of *linnen-cloth* is chiefly wrought in the provinces of *Holland*, *Frizeland*, and other parts of the united provinces, whence the appellation. The principal mart or ſtaple of this cloth is at *Haerlem*, whither it is ſent from moſt other parts as ſoon as wove, there to be whitened the enſuing ſpring.

That manufacture in *Frizeland* is the moſt eſteemed and called *Frize-Holland*. It is the ſtrongeſt and the beſt coloured of any of that fineneſs. It is never calender'd nor thickened as the reſt, but is imported juſt as it comes from the whitſter. It is diſtinguiſhed by its being yard, quarter and half wide, which is a half quarter more than thoſe commonly called *Frize-Hollands*, which are not right.

Guilix HOLLAND is very white and fine, and is chiefly uſed for ſhirts, being the ſtrongeſt of any for

for its fineneſs, except true *Frieze*. It is juſt yard wide.

Alemaer HOLLAND is a very ſtrong *cloth*, and wears exceeding well. It is about yard, quarter, and half wide.

There is a manufacture of *linnen-cloth* at *Pontivy* in *Lower Britany*, which is nothing inferior to thoſe of *Holland*, and which even excels in the ſtrength of the cloth, which wears to the full as well, and is of much more ſervice, though not ſo dear.

They have brought lately the *linnen manufacture* to a very great perfection, both in *Scotland* and *Ireland*.

After *Hollands*, or *fine Linnens* are taken from the loom, while yet raw, they are ſteeped a day in fair water, waſhed out and cleared of their filth, and thrown into a bucking tub, filled with cold lixivium, or lye of wood-aſhes and water; when taken out of the lye they are waſhed in clear water, ſpread in a meadow, and watered from time to time, with water from little diſhes, or canals along the ground, by means of ſcoops, or hollow peels of wood, called by the *Dutch*, who pretend to be the inventors of them, *gieters*: after lying a certain time on the ground, they are paſſed through a new lye poured on hot; and again waſhed in clear water, and laid a ſecond time on the ground, and every thing repeated as before; then paſſed through a ſoft gentle lye, to diſpoſe them to reſume the ſoftneſs which the other harſheſt lye had taken from them, waſhed in clear water, ſoaped with black ſoap, and that ſoap again waſhed out in clear water; they are then ſteeped in cow's milk, the cream firſt ſkimmed off, which finiſhes their whitening; and ſcowering gives them a ſoftneſs, and makes them caſt a little nap: when taken out of the milk, they are waſhed in clear water for the laſt time. After all this proceſs, they give the linnen its firſt blue, by paſſing it through a water wherein a little ſtarch, ſmalt, and *Dutch* lapis have been ſteeped. Laſtly, the proper ſtiffneſs and luſtre is given with ſtarch, pale ſmalt, and other gums, the quantity and quality whereof may be adjuſted according to occaſion.

In fine weather, the whole proceſs of *bleaching* is compleated in a month's time; in bad weather it takes up ſix weeks, or more.

To *bleach coarſe linnens*; they are taken from the loom and laid in wooden frames, full of cold water; where, by means of wooden hammers, worked by a water mill, they are beat ſo, as inſenſibly to waſh and purge them of their filth, then ſpread on the ground, where the dew, which they receive for eight days, takes off more of their impurity; then put in a kind of wooden tubs or pans, with a hot lye over them, thus lixiviated, they are again purged in the milk, laid afreſh on the ground, and after eight days more, paſſed through a ſecond lye, and all things repeated, till ſuch time as they have acquired a juſt degree of whiteneſs.

Perſons appointed by the truſtees, for improving the hempen and flaxen manufactures in *Scotland*, may enter into any bleach yard, back houſe, *&c.* and ſearch all rooms, reives, and boilers therein, and view the lyes, refuſe, and dregs thereof; to ſee whether there have been any lime, pigeons dung, or ſoap-dregs uſed in the *bleaching* of linnen cloth or yarn, contrary to the ſtatutes, 13 *G. c.* 26. § 16.

MUSLIN is alſo a fine ſort of cloth, wholly cotton; ſo called as not being bare, but not having a downy nap on its ſurface, reſembling moſs, which the *French* call *Mouſſe*.

There are various kinds of *muſlins* brought from the *Eaſt-Indies*, *Chyl*, *Bengal*, *Betelles*, *Tarnatans*, *Mulmuls*, *Tangeels*, *Terrindans*, *Douas*, &c.

WEIGHT.

WEIGHT, GRAVITY, in phyſics, a quality in natural bodies whereby they tend downwards, towards the center of the earth. Or, weight may be defined, in a leſs limited manner, to be a power inherent in all bodies whereby they tend to ſome common point, called the center of gravity; and that with a greater or leſs velocity, as they are more or leſs denſe, or as the medium they paſs through is more or leſs rare.

In the common uſe of language, weight and gravity are conſidered as one and the ſame thing. Some authors, however, make a difference between them; and hold gravity only to expreſs a niſus or endeavour to deſcend, but weight an actual deſcent. But there is room for a better diſtinction. In effect, one may conceive gravity to be the quality as inherent in the body; and weight the ſame quality, exerting itſelf either againſt an obſtacle, or otherwiſe. Hence, weight may be diſtinguiſhed, like gravity, into abſolute and ſpecific.

Sir Iſaac Newton demonſtrates, that the weights of all bodies, at equal diſtances from the center of the earth, are proportionable to the quantities of matter each contains. Whence it follows, that the weights of bodies have not any dependence on their forms, or textures; and that all ſpaces are not equally full of matter. Hence, alſo, it follows,

lows, that the weight of the same body is different, on the surface of different parts of the earth; by reason its figure is not a sphere, but a spheroid.

Weight, in mechanics, is any thing to be raised, sustained, or moved by a machine, or any thing that in any manner resists the motion to be produced.

Weight, in commerce, denotes a body of a known weight, appointed to be put in the ballance against other bodies, whose weight is required.

The security of commerce depending, in good measure, on the justness of weights, which are usually of lead, iron, or brass, most nations have taken care to prevent the falsification thereof, by stamping or marking them by proper officers, after being adjusted by some original standard. Thus, in England, the standard of weights is kept in the exchequer, by a particular officer called the clerk of the market.

Weights may be distinguished into ancient and modern, foreign and domestic.

Antient Weights, 1. Those of the antient Jews, reduced to the English troy weights, will stand as in the following table:

				lb.	oz.	dwt.	gr.
Shekel				00	00	09	$02\frac{4}{7}$
60	Maneh			02	03	06	$10\frac{2}{7}$
3000	50	Talent		113	10	01	$10\frac{2}{7}$

2. Grecian and Roman weights, reduced to English troy weight, will stand as in the following table.

									oz.	dwt.	gr.
Lentes									00	00	$00\frac{33}{112}$
4	Siliquæ								00	00	$00\frac{1}{28}$
12	3	Obolus							00	00	$09\frac{3}{28}$
24	6	2	Scriptulum						00	00	$18\frac{3}{14}$
72	18	6	3	Drachma					00	02	$06\frac{9}{14}$
96	24	8	4	$1\frac{1}{3}$	Sextula				00	03	$00\frac{6}{7}$
144	56	12	6	2	$1\frac{1}{2}$	Sicilicus			00	04	$13\frac{5}{7}$
192	48	16	8	$2\frac{2}{3}$	2	$1\frac{1}{3}$	Duella		00	06	$01\frac{1}{7}$
576	144	48	24	8	6	4	3	Uncia	00	18	$05\frac{1}{7}$
6912	1728	576	288	96	72	48	36	12 Libra	10	18	$13\frac{5}{7}$

The Roman ounce is the English avoirdupois ounce, which they divided into seven denarii, as well as eight drachms; and since they reckoned their denarius equal to the attic drachm, this will make the attic weights one eighth heavier than the corresponding Roman weights.

Modern European Weights. 1. English weights: By the twenty-seventh chapter of magna charta, the weights all over England are to be the same; but for different commodities, there are two different sorts, *viz.* Troy weight and avoirdupoise weight. The origin from which they are both raised, is a grain of weight, gathered in the middle of the ear.

In troy weight, twenty-four of these grains make a penny-weight sterling; twenty penny-weights make one ounce, and twelve ounces one pound.

By this weight we weigh gold, silver, jewels, grains, and liquors. The apothecaries also use the troy pound, ounce, and grain; but they differ from the rest in the intermediate divisions. They divide the ounce into eight drachms; the drachm into three scruples, and the scruple into twenty grains.

In avoirdupoise weight, the pound contains sixteen ounces, but the ounce is less by near one twelfth than the troy ounce; this latter containing 490 grains, and the former only 448. The ounce contains 16 drachms. 80 ounces avoirdupoise are only equal to 73 ounces troy; and 17 pounds troy equal to 14 pounds avoirdupoise.

By avoirdupoise weight are weighed mercury, and grocery wares, base metals, wool, tallow, hemp, drugs, bread, *&c.*

Table

Table of Troy Weight as uſed by the

Goldſmiths.

Grains.

24	Penny-weight.		
480	20	Ounce.	
5760	240	12	Pound.

Apothecaries.

Grains.

20	Scruple.		
60	3	Drachm.	
480	24	8	Ounce.
5760	288	96	12 Pound.

Table of Avoirdupoiſe Weight.

Scruples.

3	Drachm.				
24	8	Ounce.			
384	128	16	Pound.		
43008	14336	1792	112	Quintal, or Hundred.	
860160	286720	35840	2240	20	Ton.

The moneyers, jewellers, *&c.* have a particular claſs of weights, for gold and precious ſtones, *viz.* carat and grain; and for ſilver, the penny-weight and grain.

The moneyers have alſo a peculiar ſubdiviſion of the grain troy: thus,

The { Grain, Mite, Droit, Perit } into { 20 Mites, 24 Droits, 20 Perits, 24 Blanks. }

The dealers in wool have likewiſe a particular ſet of weights, *viz.* the ſack, weigh, tod, ſtone, and clove.

Grains.

24	Penny-weight.				
72	3	Gros.			
576	24	8	Ounce.		
4608	192	64	8	Marc.	
9216	384	128	16	2	Pound.

2. French weights: the common or Paris pound is 16 ounces; which they divide two ways: the firſt diviſion is into 2 marcs; the marc into 8 ounces; the ounce into 8 gros; the gros into 3 pennyweights; the pennyweight into 24 grains; the grain equivalent to a grain of wheat. The ſecond diviſion of the pound is into 2 half-pounds; the half-pound into 2 quarters; the quarter into 2 half-quarters; the half-quarter into two ounces; and the ounce into two half-ounces.

The weights of the firſt diviſion are uſed to weigh gold, ſilver, and the richer commodities: and the weights of the ſecond diviſion, for commodities of leſs value.

Half-ounce.

2	Ounce.					
4	2	Half-quarter pound.				
8	4	2	Quarter-pound.			
16	8	4	2	Half-pound.		
32	16	8	4	2	Pound.	
3200	1600	800	400	200	100	Quintal.

But the pound is not the ſame throughout France. At Lyons, *e. gr.* the city pound is only 14 ounces: ſo that 100 Lyons pounds makes only 88 Paris pounds. But beſides the city pound, they have another at Lyons for ſilk, containing 16 ounces. At Tholouſe, and throughout the Upper Languedoc, the pound is 13 ounces and a half of Paris weight. At Marſeilles, and throughout Provence, the pound is 13 ounces of Paris weight. At Rouen, beſide the common Paris pound and marc, they have the weight of the vicomte; which is 16 ounces, a half, and five-ſixths of the Paris weight. The weights, enumerated under the two articles of Engliſh and French weights, are the ſame that are uſed throughout the greateſt part of Europe; only under ſomewhat different names, diviſions and proportions.

Particular nations have alſo certain weights peculiar to themſelves: thus, Spain has its arrobas, containing 25 Spaniſh pounds, or one-fourth of the

the common quintal: its quintal macho, containing 150 pounds, or one half common quintal, or 6 arrobas: its adarme, containing one ſixteenth of its ounce. And for gold, it has its caſtillan, or one-hundredth of a pound. Its tomin, containing 12 grains, or one eighth of a caſtillan. The ſame are in uſe in the Spaniſh Weſt-Indies.

Portugal has its arroba, containing 32 Liſbon arratels, or pounds: Savary alſo mentions its faratelle, containing 2 Liſbon pounds: and its rottoli, containing about 12 pounds. And for gold, its chego, containing four carats. The ſame are uſed in the Portugueſe Eaſt-Indies.

Italy, and particularly Venice, have their migliaro, containing four mirres; the mirre containing 30 Venice pounds: the ſaggio, containing a ſixth part of an ounce. Genoa has five kinds of weights, *viz.* large weights, whereby all merchandizes are weighed at the cuſtom-houſe: caſh weights for piaſtres, and other ſpecies: the cantara, or quintal, for the coarſeſt commodities: the large ballance for raw ſilks; and the ſmall ballance for the finer commodities. Sicily has its rottolo, 32 and a half pounds of Meſſina.

Germany, Flanders, Holland, the Hanſe towns, Sweden, Denmark, Poland, *&c.* have their ſchippondt, which at Antwerp and Hamburgh, is 300 pounds; at Lubeck, 320; and at Coningſberg, 400 pounds. In Sweden, the ſchippondt for copper is 320 pounds; and the ſchippondt for proviſions 400 pounds. At Riga and Revel, the ſchippondt is 400 pounds; at Dantzic, 340 pounds; in Norway, 300 pounds; at Amſterdam, 300: containing 20 lyſpondts, each weighing 15 pounds.

In Muſcovy, they weigh their large commodidities by the bercheroct, or berkewits, containing 400 of their pounds. They have alſo the poet, or poede, containing 40 pounds, or one tenth of the bercheroct.

In order to ſhew the proportion of the ſeveral weights uſed throughout Europe, we ſhall add a reduction of them to one ſtandard, *viz.* the London and Amſterdam pound.

1. Proportion of the weights of the principal places of Europe.

The 100 lb. of England, Scotland, and Ireland, are equal to

lb.	oz.	
91	8	of Amſterdam, Paris, *&c.*
96	8	of Antwerp or Brabant.
88	0	of Rouen, the viſcounty weight.
106	0	of Lyons, the city weight.
90	9	of Rochelle.
107	11	of Toulouſe and upper Languedoc.
113	0	of Marſeilles or Provence.
81	7	of Geneva.
93	5	of Hamburgh.
89	7	of Francfort, *&c.*
96	1	of Leipſick, *&c.*
137	4	of Genoa.
132	11	of Leghorn.
153	11	of Milan.
152	0	of Venice.
154	10	of Naples.
97	0	of Seville, Cadiz, *&c.*
104	13	of Portugal.
96	5	of Leige.
112	$\frac{2}{3}$	of Ruſſia.
107	$\frac{1}{24}$	of Sweden.
89	$\frac{1}{2}$	of Denmark.

2. Proportion of weights of the chief cities in Europe, to thoſe of Amſterdam.

An 100 pounds of Amſterdam are equal to

lb.	
108	of Alicant.
105	of Antwerp.
120	of Archangel, or 3 poedes.
105	of Arſchot.
120	of Avignon.
98	of Baſil in Switzerland.
100	of Bayonne in France.
166	of Bergamo.
97	of Bergen-op-zom.
95 $\frac{1}{4}$	of Bergen in Norway.
111	of Bern.
100	of Beſançon.
100	of Bilboa.
105	of Bois le duc.
151	of Bologna.
100	of Bourdeaux.
104	of Bourg en Breſſe.
103	of Bremen.
125	of Breſlaw.
105	of Bruges.
105	of Bruſſels.
105	of Cadiz.
105	of Cologne.
125	of Coningſberg.
107 $\frac{1}{2}$	of Copenhagen.
87	rottos of Conſtantinople.
113 $\frac{1}{2}$	of Dantzic.
100	of Dort.
97	of Dublin.
97	of Edinburgh.
143	of Florence.
98	of Francfort on the Maine.
105	of Gaunt.
89	of Geneva.

lb.
163 of Genoa, caſh weight.
102 of Hamburgh.
106 of Leyden.
105 of Leipſic.
105 ½ of Liege.
114 of Liſle.
143 of Leghorn.
106 ½ of Liſbon.
109 of London, avoirdupoiſe weight.
105 of Lovaine.
105 of Lubec.
141 ½ of Lucca, light weight.
116 of Lyons, city weight.
114 of Madrid.
105 of Marlines.
123 ½ of Marſeilles.
154 of Meſſina, light weight.
168 of Milan.
120 of Montpelier.
125 bercheroets of Muſcovy.
100 of Nantes.
106 of Nancy.
169 of Naples.
98 of Nuremberg.
100 of Paris.
112 ½ of Revel.
109 of Riga.
100 of Rochelle.
146 of Rome.
100 of Rotterdam.
96 of Rouen, viſcounty weight.
100 of St. Malo.
100 of St. Sebaſtian.
158 ½ of Saragoſa.
106 of Seville.
114 of Smyrna.
110 of Stetin.
81 of Tholouſe and upper Languedoc.
151 of Turin.
158 ½ of Valencia.
182 of Venice, ſmall weight.

WEIGHTS, *uſed in the ſeveral parts of Aſia, the Eaſt-Indies, China, Perſia, &c.* In Turky, at Smyrna, *&c.* they uſe the batman, or battemant, containing ſix occos; the occo weighing three pounds four-fifths Engliſh. They have another batman much leſs, conſiſting, as the former, of ſix occos: but the occo only containing fifteen ounces Engliſh: 44 occos of the firſt kind make the Turkiſh quintal. At Cairo, Alexandretta, Aleppo, and Alexandria, they uſe the rotto, rotton, or rottoli. The rottoli at Cairo, and other parts of Egypt, is 144 drachms; being ſomewhat over an Engliſh pound. At Aleppo there are three ſorts of rottos: the firſt 720 drachms, making about ſeven pounds Engliſh, and ſerving to weigh cottons, galls, and other large commodities; the ſecond is 624 drachms, uſed for all ſilks but white ones, which are weighed by the third rotto of 700 drachms. At Seyda the rotto is 600 drachms.

The other ports of the Levant, not named here, uſe ſome of theſe weights; particularly the occo ar ocqua, the rottoli, and rotto.

The Chineſe weights are the piece for large commodities; it is divided into 100 catis, or cattis; though ſome ſome ſay into 125; the cati into 16 taels, or tales; each tael equivalent to 1 ⅓ of an ounce Engliſh, or the weight of one rial and $\frac{1}{12}$, and containing 12 mas or maſſes, and each mas 10 condrins. So that the Chineſe piece amounts to 137 pounds Engliſh avoirdupoiſe, and the cati to 1 pound 8 ounces. The picol for ſilk containinſi 66 catis and ¾, the bahar, bakaire, or barr, containing 300 catis.

Tonquin has alſo the ſame weights, meaſures, *&c.* as China. Japan has only one weight, *viz.* the cati; which, however, is different from that of China, as containing 20 taels. At Surat, Agra, and throughout the ſtates of the great Mogul, they uſe the man, or maund, whereof they have two kinds; the king's man, or king's weight; and the man ſimply; the firſt uſed for the weighing of common proviſions, containing 40 ſeers or ſerres; and each ſeer a juſt Paris pound. The common man, uſed in the weighing of merchandize, conſiſts likewiſe of 40 ſeers, but each ſeer is only eſtimated at 12 Paris ounces, or ¾ of the other ſeer.

The man may be looked on as the common weight of the Eaſt-Indies, though under ſome difference of name, or rather of pronunciation; it being called mao at Cambaya, and in other places mein, and maun. The ſeer is properly the Indian pound, and of univerſal uſe; the like may be ſaid of the bahar, tael, and catti above-mentioned.

The weights of Siam, are the piece, containing two ſhans, or cattis; but the Siameſe catti is only half the Japoneſe, the latter containing 20 taels, and the former only 10; though ſome make the Chineſe catti only 16 taels, and the Siameſe 8. The tael contains four baats or ticals; each about a Paris ounce; the baat 4 ſelings or mayons; the mayon 2 fouangs; the fouang four payes; the paye 2 clams; and the ſompaye half a fouang.

It is to be obſerved, that thoſe are the names of their coins as well as weights; ſilver and gold being commodities there ſold, as other things, by their weights.

In the iſle of Java, and particularly at Bantam, they uſe the gantan, which amounts to near three Dutch pounds. In Golconda, at Viſapour and Goa, they have the furatelle, containing 1 pound 14 ounces Engliſh; the mangalis or mangelin for weighing diamonds and precious ſtones, weighing at Goa 5 grains, at Golconda, *&c.* 5 ½ grains. They have alſo the rotolo containing 14 ½ ounces Engliſh; the metricol containing the ſixth part of an ounce; the wall for piaſters and ducats, containing the 73d part of a rial.

In Perſia they uſe two kinds of batmans or mans, the one called cahi or cheray, which is the King's weight; and the other batman of Tauris. The firſt weighs 13 pounds 10 ounces Engliſh; the ſecond 6 pounds ½. Its diviſions are the ratel, or a 16th; the derhem or drachm, which is the 50th; the meſchal, which is half the derhem; the dung, which is the 6th part of the meſchal, being equivalent to ſix carat-grains; and, laſtly, the grain, which is the fourth part of the dung. They have alſo the vakie, which exceeds a little our ounce; the ſah-cheray, equal to the 1170th part of th derhem; and the toman uſed to weigh our large payments of money, without telling; its weight is that of 50 abaſſis.

African and American weights. We have little to ſay as to the weights of America: the ſeveral European colonies there making uſe of the weights of the ſtates or kingdoms of Europe they belong to. For, as to the aroue of Peru, which weighs 27 pounds, it is evidently no other than the Spaniſh arroba with a little difference in the name.

As to the weights of Africa, there are few places that have any, except Egypt, and the countries bordering on the Mediterranean, whoſe weights have been already enumerated among thoſe of the ports of the Levant. The iſland of Madagaſcar indeed has weights, but none that exceed the drachm, nor are they uſed for any thing but gold and ſilver.

W I N E.

WINE, a briſk, agreable, ſpirituous and cordial liquor, drawn from vegetable bodies and fermented.

The character of a wine, according to Boerhaave, is, that the firſt thing it affords by diſtillation, be a thin, oily, inflammable fluid called a ſpirit.

This diſtinguiſhes wines from another claſs of fermented vegetable juices, *viz.* vinegar, which inſtead of ſuch ſpirit, yields, for the firſt thing, an acid uninflammable matter.

All ſorts of vegetables, fruits, ſeeds, roots, *&c.* afford wine; as grapes, currants, mulberries, elder-berries, cherries, apples, pulſe, beans, peaſe, turneps, radiſhes, and even graſs itſelf. Hence under the claſs of wines, or vinous liquors, come not only wines abſolutely ſo called, but alſo ale, cyder, *&c.*

WINE is, in a more peculiar manner, appropriated to that, which is drawn from the fruit of the vine, by ſtamping its grapes in a vat, or cruſhing and expreſſing the juice out of them in a preſs, and then fermenting, *&c.*

The goodneſs of wine conſiſts in its being neat, dry, fine, bright, and briſk, without any taſte of the ſoil, of a clean ſteddy colour, having a ſtrength without being heady, a body without being ſour, and keeping without growing hard or eager. The difference of flavour, taſte, colour, and body, in wines, is, perhaps, as much owing to the different manner and time of preſſing, gathering, fermenting *&c.* the grape, as to any difference of the grape itſelf. In Hungary, whence tockay and ſome of the richeſt and higheſt flavoured wines come, they are extremely curious in theſe reſpects: for their prime and moſt delicate wines, the grape is ſuffered to continue upon the vine, till it is half dried by the heat of the ſun; and, if the ſun's heat ſhould not prove ſufficient, they are dried by the gentle heat of a furnace, and then picked one by one from the ſtalks; the juice of this grape, when preſſed out, is of a fine flavour, and ſweet as ſugar: this, after due fermentation, is kept for a year, and then racked from the lees, when it proves a generous, oily, rich wine, and is ſold at a very high rate. The Hungarians prepare a ſecond ſort of wine, by collecting together the better kind of grapes, carefully picking the better kind of grapes, carefully picking the fruit from the ſtalks, and then preſſing out the juice: this is extremely ſweet, and is made richer by infuſing in it, after it has fermented for ſome days, a ſufficient quantity of half dried grapes. This wine is very ſweet, oily of a grateful taſte, and retains theſe qualities for a long time. There is a third ſort made from the pure juice of the ſame kind of grape, without any addition. This is a more briſk and lively wine, and far leſs ſweet. They likewiſe prepare a fourth ſort, from grapes of different goodneſs mixed together; this though not ſo generous, is nevertheleſs an excellent wine. Theſe Hungarian wines

are

are remarkable for preſerving their ſweetneſs, and for the delicacy of their taſte and ſmell; they, likewiſe, do not grow eaſily vapid, and may be kept in perfection for many years.

Wine being a liquor moſtly of foreign produce, the divers names, forms, kinds, diſtinctions, &c. thereof, are borrowed from the countries where it is produced; the principal whereof, at this day, is France, to wines of which country, a good part of what we have to ſay of this noble liquor, will more immediately belong.

Wine in France is diſtinguiſhed from the ſeveral degrees and ſteps of its preparation, into, 1. *Mere goutte*, mother drop, which is the virgin wine, or that which runs of itſelf out at the top of the vat wherein the grapes are laid, before the vintager enters to tred or ſtamp the grapes. 2. Muſt, ſurmuſt, or ſtum, which is the wine or liquor in the vat, after the grapes have been trod or ſtamped. 3. Preſſed wine, being that ſqueezed with a preſs out of the grapes half bruiſed by the treading. The huſks left of the grapes are called rope, murk, or mark, by throwing water upon which, and preſſing them afreſh, they make a liquor for ſervants uſe, anſwerable to our cyderkin, and called *boiſon*, which is of ſome uſe in medicine, in the cure of diſorders occaſioned by viſcid humours. 4. Sweet wine, is that which has not yet worked nor fermented. 5. Bouru, that which has been prevented working by caſting in cold water. 6. Worked wine, that which has been let work in the vat, to give it a colour. 7. Boiled wine, that which has had a boiling before it worked, and which by that means ſtill retains its native ſweetneſs. 8. Strained wine, that made by ſteeping dry grapes in water, and letting it ferment of itſelf. Wines are alſo diſtinguiſhed with regard to their colour into white wine, red wine, claret wine, pale wine, roſe, or black wine; and with regard to their country, or the ſoil that produces them, into French wines, Spaniſh wines, Rheniſh wines, Hungary wines, Greek wines, Canary wines, &c. and more particularly into Port wine, Madeira wine, Burgundy wine, Champaign wine, Falernian wine, Tockay wine, Schiras wine, &c.

Method of making, fining, &c. WINE. In the ſouthern parts of France, their way is with red wines to tread or ſqueeze the grapes between the hands, and to let the whole ſtand, juice and huſks, till the tincture be to their liking; after which they preſs it. But for white wines, they preſs the grapes immediately; when preſſed, they tun the muſt and ſtop up the veſſel, only leaving the dept of a foot or more to give room for it to work.

At the end of ten days they fill this ſpace with ſome other proper wine, that will not provoke it to work again. This they repeat from time to time, new wine ſpending itſelf a little before it comes to perfection.

The uſual method of fining down wines, ſo as to render them expeditiouſly bright, clear, and fit for uſe, is this. Take an ounce of iſinglaſs, beat it into thin ſhreads with a hammer, and diſſolve it, by boiling, in a pint of water; this, when cold, becomes a ſtiff jelly. Whiſk up ſome of this jelly into a froth with a little of the wine intended to be fined, then ſtir it well among the reſt in the caſk, and bung it down tight; by this means the wine will become bright in eight or ten days. This method, however, is found to be beſt ſuited to the white wines; for the red ones, the wine-coopers commonly uſe the whites of eggs beat up to a froth, and mixed in the ſame manner with their wines.

They fine it down alſo by putting the ſhavings of green beech into the veſſel, having firſt taken off all the rind, and boiled them an hour in water to extract their rankneſs, and afterwards dried them in the ſun, or in an oven. A buſhel of theſe ſerve for a tun of wine; and being maſhed, they ſerve again and again, till almoſt quite conſumed.

For Engliſh wine, the method recommended by Mortimer, is firſt to gather the grapes when very dry, to pick them from the ſtalks, then to preſs them, and let the juice ſtand twenty-four hours in a vat covered. Afterwards to draw it off from the groſs lees, and then put it up in a caſk, and to add a pint or quart of ſtrong red or white port to every gallon of juice, and let the whole work, bunging it up cloſe, and letting it ſtand till January; then bottle it in dry weather. Bradley chuſes to have the liquor, when preſſed, ſtand with the huſks, ſtalks, and all in the vat, to ferment for fifteen days.

The method of converting white-wine into red, ſo much practiſed by the modern wine-coopers, Dr. Shaw obſerves, is this. Put four ounces of turneſole rags into an earthen veſſel, and pour upon them a pint of boiling water; cover the veſſel cloſe, and leave it to cool; ſtrain off the liquor, which will be of a fine deep red, inclining to purple. A ſmall portion of this colours a large quantity of wine. This tincture might be either made in brandy, or mixed with it, or elſe made into a ſyrup, with ſugar, for keeping. A common way with the wine-coopers is to infuſe the rags cold in wine for a night or more, and then wring them out with their hands; but the inconveniency of this method is, that it gives the wine a diſagreeable taſte; or what is commonly called the taſte of the rag; whence the wines, thus coloured, uſually paſs among judges for preſſed wines,

which have all this taſte from the canvas rags in which the lees are preſſed.

The way of extracting the tincture, as here directed, is not attended with this inconvenience; but it loads the wine with water; and if made into a ſyrup, or mixed in brandy, it would load the wine with things not wanted, ſince the colour alone is required. Hence the colouring of wines has always its inconveniencies.

In thoſe countries which do not produce the tinging grape, which affords a blood-red juice, wherewith the wines of France are often ſtained, in defect of this, the juice of elder-berries is uſed, and ſometimes logwood is uſed at Oporto.

The colour afforded by the method here propoſed, gives wine the tinge of the Bourdeaux-red, not the Port; whence the foreign coopers are often diſtreſſed for want of a proper colouring for red wines in bad years. This might, perhaps, be ſupplied by an extract made by boiling ſticklack in water. The ſkins of tinging-grapes might alſo be uſed, and the matter of the turneſole procured in a ſolid form, not imbibed in rags.

Stahl obſerves, that it is a common accident, and a diſeaſe in wines, to be kept too hot; which is not eaſy to cure when it has been of any long continuance, otherwiſe it may be cured by introducing a ſmall artificial fermentation, that new ranges the parts of the wine, or rather recovers their former texture: but the actual expoſing of wine to the fire, or the ſun, preſently diſpoſes it to turn eager; and the making it boiling hot, is one of the quickeſt ways of expediting the proceſs of making of vinegar.

On the other hand, wine kept in a cool vault, and well ſecured from the external air, will preſerve its texture entire in all the conſtituent parts; and ſufficiently ſtrong for many years, as appears not only from old wines, but other foreign fermented liquors, particularly thoſe of China, prepared from a decoction of rice, which being well cloſed down in a veſſel, and buried deep under ground, will continue, for a long ſeries of years, rich, generous, and good, as the hiſtories of that country univerſally agree in aſſuring us.

The moſt general remedy hitherto known for all the diſeaſes of wines, is a prudent uſe of tartarized ſpirit of wine, which not only enriches, but diſpoſes all ordinary wines to grow fine.

If either by fraud or accident a larger portion of water is mixed with wine than is proper for its conſiſtence, and no way neceſſary or eſſential, this ſuperfluous water does not only deprave the taſte, and ſpoil the excellence of the wine, but alſo renders it leſs durable; for humidity in general, and much more a ſuperfluous aqueous humidity, is the primary and reſtleſs inſtrument of all the changes that are brought on by fermentation. It may doubtleſs, therefore, be uſeful, and ſometimes abſolutely neceſſary, to take away this ſuperfluous water from the other part which ſtrictly and properly conſtitutes the wine. This has been agreed upon on all hands as a thing proper; but the manner of doing it has not been well agreed on; ſome have propoſed the effecting it by means of heat and evaporation, others by percolation, and others by various other methods, all found unſucceſsful when brought to the trial; but the way propoſed by Dr. Shaw from Stahl, is the moſt certain and commodious; this is done by a concentration of the wine, not by means of heat, but of cold.

If any kind of wine, but particularly ſuch as has never been adulterated, be in a ſufficient quantity, as that of a gallon or more, expoſed to a ſufficient degree of cold in froſty weather, or be put into any place where ice continues all the year, as in our ice-houſes, and there ſuffered to freeze, the ſuperfluous water that was originally contained in the wine, will be frozen into ice, and will leave the proper and truly eſſential part of the wine unfrozen, unleſs the degree of cold ſhould be very intenſe, or the wine but weak and poor. This is the principle on which Stahl founds his whole ſyſtem of condenſing wines by cold. When the froſt is moderate, the experiment has no difficulty, becauſe not above a third or a fourth part of the ſuperfluous water will be froze in a whole night; but if the cold be very intenſe, the beſt way is, at the end of a few hours, when a tolerable quantity of ice is formed, to pour out the remaining fluid liquor, and ſet it in another veſſel to freeze again by itſelf. If the veſſel, that thus by degrees receives the ſeveral parcels of the condenſed wine, be ſuffered to ſtand in the cold freezing place where the operation is performed, the quantity lying thin in the pouring out, or otherwiſe, will be very apt to freeze anew; and if it be ſet in a warm place, ſome of this aqueous part thaws again, and ſo weakens the reſt. The condenſed wine, therefore, ſhould be emptied in ſome place of a moderate degree as to cold or heat, where neither the ice may diſſolve, nor the vinous ſubſtance mixed among it be congealed. But the beſt expedient of all is to perform the operation with a large quantity of wine, or that of ſeveral gallons, where the utmoſt exactneſs, or the danger of a trifling waſte, need not be regarded.

By this method, when properly performed, there firſt freezes about one third part of the whole liquor; and this is properly the more purely

purely aqueous part of it, insomuch that when all the vinous fluid is poured off, to be again exposed to a concentration, the ice remaining behind, from this first freezing, being set to thaw in a warm place, dissolves into a pure and tasteless water. The frozen part, or ice, consists only of the watery part of the wine, and may be thrown away, and the liquid part retains all the strength, and is to be preserved. This will never grow sour, musty, or mouldy afterwards, and may at any time be reduced to wine of the common kind again, by adding to it as much water as will make it up to the quantity that it was before.

Wines in general may by this method be reduced to any degree of vinosity or perfection.

The benefit and advantage of this method of congelation, if reduced to practice in the large way, in the wine countries, must be evident to every body. Concentrated wines, in this manner, might be sent into foreign countries, instead of wine and water, which is what is usually now sent, the wines they export being loaded, and in danger of being spoiled by three or four times their own quantity of unnecessary, superfluous, and prejudicial water.

An easy method of recovering pricked wines, may be learned from the following experiment: take a bottle of red port that is pricked, add to it half an ounce of tartarized spirit of wine, shake the liquor well together, and set it by for a few days, and it will be found very remarkably altered for the better.

This experiment depends upon the useful doctrine of acids and alkalies. All perfect wines have naturally some acidity, and when this acidity prevails too much, the wine is said to be pricked, which is truly a state of the wine tending to vinegar: but the introduction of a fine alkaline salt, such as that of tartar, imbibed by spirit of wine, has a direct power of taking off the acidity, and the spirit of wine also contributes to this, as a great preservative in general of wines.

If this operation be dextrously performed, pricked wines may be absolutely recovered by it, and remain saleable for some time: and the same method may be used to malt liquors just turned sour.

The age of wine is properly reckoned by leaves; thus they say wine of two, four, or six leaves, to signify wine of two, four, or six years old; taking each new leaf put forth by the vine, since the wine was made, for a year.

The net duties to be paid on importation of all wines into the port of London, and repaid on exportation, are as follows.

Wines imported by British for sale. Rhenish, German, or Hungary wines, the ton, filled in casks, pay, on importation, 35l. 2s. $\frac{72}{100}$d. and on exportation, draw back 26l. 13s. $8\frac{88}{100}$d. in bottles, on importation, 35l. 15s. $3\frac{12}{100}$d. and draw back, on exportation, 27l. 5s. $4\frac{8}{100}$d. Portugal or Madeira wine, the ton filled in casks, pays on importation, 28l. 8s. $3\frac{12}{100}$d. and, on exportation, draws back 20l. 6s. $4\frac{8}{100}$d. in bottles, on importation, 31l. 5s. $3\frac{12}{100}$d. and, on exportation, draws back 22l. 15s. $4\frac{8}{100}$d. French wine, the ton filled in cask, on importation, pays 60l. 16s. $4\frac{8}{100}$d. and, on exportation, draws back, 26l. 2s. $11\frac{12}{100}$d. in bottles, on importation, 64l. 5s. $4\frac{8}{100}$d. and, on exportation, draws back 27l. 18s. $8\frac{72}{100}$d. Levant and all other wines, the ton filled in casks pays, on importation, 29l. 4s. $9\frac{12}{100}$d. and, on exportation, draws back 21l. 2s. $10\frac{8}{100}$d. in bottles, on importation, pays 32l. 3s. $9\frac{12}{100}$d. and, on exportation, draws back, 23l. 13s. $10\frac{8}{100}$d. Wines imported by British for private use. Rhenish, German, or Hungary wine, the ton filled in casks, pays, on importation, 36l. $3\frac{60}{100}$d. and, on exportation, draws back 27l. 5s. $10\frac{80}{100}$d. in bottles, on importation, the ton pays 36l. 13s 6d. and, on exportation, draws back, 27l. 17s. 6d. Portugal or Madeira wine, the ton filled in casks, on importation, pays 29l. 6s. 6d. and, on exportation, draws back 20l. 18s. 6d. in bottles, on importation, 32l. 3s. 6d, and, on exportation, draws back 23l. 7s. 6d. French wine, the ton filled in casks, pays, on importation, 61l. 8s. 6d. and, on exportation, draws back 26l. 11s. $4\frac{40}{100}$d. in bottles, on importation, 64l. 17s. 6d. and, on exportation, draws back 28l. 6s. 10d. Levant and all all other wines, the ton filled in casks, pays, on importation, 30l. 3s. and, on exportation, draws back 21l. 15s. in bottles, on importation, 33l. 2s. and, on exportation, draws back 24l. 6s. And besides the afore-mentioned duties, all wines imported into the Port of London, are to pay to the use of the orphans of the said city, for every ton, 4s.

Wines imported by foreigners are to pay, besides the aforesaid duties, the under-mentioned, which must be added respectively to the duties payable by British. Rhenish, German or Hungary wines, the ton filled in casks, on importation, pays 4l. 8s. $2\frac{40}{100}$d. and, on exportation, draws back 4l. 3s. $2\frac{40}{100}$d. in bottles, on importation, 4l. 10s. and, on exportation, draws back 4l. 5s. French wine, the ton in casks, pays, on importation, 4l. 4s. $7\frac{20}{100}$d. and, on exportation, draws back 3l. 19s. $7\frac{20}{100}$d. in bottles, on importation, 4l. 10s. and, on exportation, draws back 4l. 5s. Levant and all other wines, filled in casks, the ton pays, on importation, 4l. 1s. and, on exportation, draws back 3l. 16s. in bottles, on importation, 4l. 10s. and, on exportation, draws back 4l. 5s. And besides those

duties,

duties, all wines of the growth of the Levant, imported into any port by foreigners, are to pay to the uſe of the town of Southampton, for every butt or pipe, 10s.

Wine is alſo a denomination applied in medicine and pharmacy to divers mixtures and compoſitions wherein the juice of the grape is a principal ingredient.

With regard to the medical uſes of wines, it is obſerved, that among the great variety of wines in common uſe among us, five are employed in the ſhops as menſtrua for medicinal ſimples; that is, the vinum album Hiſpanicum, or mountain wine; the vinum album gallicum, or French white wine; the Canary wine, or ſack; the rheniſh wine; and the red port. The effects of theſe liquors on the human body, are to chear the ſpirits, warm the habit, promote perſpiration, render the veſſels full and turgid, raiſe the pulſe, and quicken the circulation. The effects of the full bodied wines are much more durable than thoſe of the thinner; all ſweet wines, as Canary, abound with a glutinous, nutritious ſubſtance, whilſt the others are not nutrimental, or only accidentally ſo, by ſtrengthening the organs employed in digeſtion. Sweet wines, in general, do not paſs off freely by urine; and they heat the conſtitution more than an equal quantity of any other, though containing full as much ſpirit: red port, and moſt of the red wines, have an aſtringent quality, by which they ſtrenghen the tone of the ſtomach, and thus prove ſerviceable for reſtraining immoderate ſecretions; thoſe which are of an acid nature, as rheniſh, paſs freely by the kidneys, and gently looſen the belly. It is ſuppoſed that theſe laſt exaſperate and occaſion gouty calculous diſorders, and that new wines of every kind have this effect.

Wine-spirit, a term uſed by our diſtillers, and which may ſeem to mean the ſame thing with the phraſe of ſpirit of wine; but they are taken in very different ſenſes in the trade.

Spirit of wine is the name given to the common malt ſpirit, when reduced to an alcohol, or totally inflammable ſtate; but the phraſe wine-ſpirit is uſed to expreſs a very clean and fine ſpirit, of the ordinary proof ſtrength, and made in England from wines of foreign growth.

The way of producing it is by ſimple diſtillation, and it is never rectified any higher than common bubble proof. The ſeveral wines of different natures, yield very different proportions of ſpirit; but, in general, the ſtrongeſt yield one fourth, the weakeſt in ſpirits one eight part of proof-ſpirit; that is, they contain from a ſixteenth to an eight part of their quantity of pure alcohol.

W I R E.

Wire, wiar, wier, or wyre, a piece of metal drawn through the hole an iron into a thread of a fineneſs anſwerable to the hole it paſſed through.

Wires are frequently drawn ſo fine, as to be wrought along with other threads of ſilk, wool, flax, *&c.*

The metals moſt commonly drawn into wire, are gold, ſilver, copper, and iron.

Gold-wire is made of cylindrical ingots of ſilver, covered over with a ſkin of gold, and thus drawn ſucceſſively through a vaſt number of holes, each ſmaller and ſmaller; till at laſt it is brought to a fineneſs exceeding that of a hair. That admirable ductility which makes one of the diſtinguiſhing characters of gold, is no where more conſpicuous, than in this gilt wire. A cylinder of forty-eight ounces of ſilver, covered with a coat of gold, only weighing one ounce, as Dr. Halley informs us, is uſually drawn into a wire, two yards of which weigh no more than one grain; whence ninety-eight yards of the wire weigh no more then forty-nine grains, and one ſingle grain of gold covers the ninety-eight yards; ſo that the ten-thouſandth part of a grain is above one-eight of an inch long. The ſame author computing the thickneſs of the ſkin of gold, found it to be $\frac{1}{1134000}$ part of an inch. Yet ſo perfectly does it cover the ſilver, that even a microſcope does not diſcover any appearance of the ſilver underneath. M. Rohault likewiſe obſerves, that a like cylinder of ſilver, covered with gold, two feet eight inches long, and two inches nine lines in circumference, is drawn into a wire 307200 feet long, *i. e.* into 115200 times its former length. Mr. Boyle relates, that eight grains of gold, covering a cylinder of ſilver, is commonly drawn into a wire 13000 feet long.

Silver-wire is the ſame with gold-wire, except that the latter is gilt, or covered with gold, and the other is not.

There are alſo counterfeit gold and ſilver-wires; the firſt made of a cylinder of copper, ſilvered over, and then covered with gold; and the ſecond of a like cylinder of copper, ſilvered over, and drawn through the iron, after the ſame manner as gold and ſilver-wire.

Braſs-wire is drawn after the ſame manner as the former. Of this there are divers ſizes, ſuited to the different kinds of works. The fineſt is uſed for the ſtrings of muſical inſtruments, as ſpinets, harpſichords, manichords, *&c.* See the article spinet, *&c.*

The

The pin-makers, likewiſe, uſe vaſt quantities of braſs-wire, to make their pins of.

Iron-wire is drawn of various ſizes, from half an inch to one tenth of an inch diameter.

The firſt iron that runs from the ſtone, when melting, being the ſofteſt and tougheſt, is preſerved to make wire of. Iron-wire is made from ſmall bars of iron called eſleom iron, which are firſt drawn out to a greater length, and to about the thickneſs of ones little finger, at a furnace, with a hammer gently moved by water. Theſe thinner pieces are bored round, and put into a furnace to aneal for twelve hours. A pretty ſtrong fire is uſed for this operation. After this they are laid under water for three or four months, the longer the better; then they are delivered to the workmen, called rippers, who draw them into wire thro' two or three holes. After this they aneal them again for ſix hours, and water them a ſecond time for about a week, and they are then delivered again to the rippers, who draw them into wire of the thickneſs of a large packthread. They are then anealed a third time, and then watered for a week longer, and delivered to the ſmall wire-drawers, called over-houſe-men.

In the mill where this work is performed, there are ſeveral barrels hooped with iron, which have two hooks on their upper ſides, on each whereof hang two links, which ſtand acroſs, and are faſtened to the two ends of the tongs, which catch hold of the wire, and draw it through the hole. The axis on which the barrel moves does not run through the center, but is placed on one ſide, which is that on which the hooks are placed; and underneath their is faſtened to the barrel a ſpoke of wood, which they call a ſwingle, which is drawn back a good way by the cogs in the axis of the wheel, and draws back the barrel, which falls to again by its own weight. The tongs hanging on the hooks of the barrel, are by the workmen faſtened to the end of the wire, and by the force of the wheel, the hooks being pulled back, draw the wire through the holes. The plate in which the holes are, is iron on the outſide, and ſteel on the inſide; and the wire is anointed with train-oil, to make it run the eaſier.

WIRE *of Lapland.* The inhabitants of Lapland have a ſort of ſhining ſlender ſubſtance in uſe among them on ſeveral occaſions, which is much of the thickneſs and appearance of our ſilver-wire, and is therefore called, by thoſe who do not examine its ſtructure or ſubſtance, Lapland-wire. It is made of the ſinews of the rein-deer, which being carefully ſeparated in the eating, are by the women, after ſoaking in water, and beaten, ſpun into a ſort of thread, of admirable fineneſs and ſtrength, when wrought to the ſmalleſt filaments; but when larger, is very ſtrong, and fit for the purpoſes of ſtrength and force. Their wire, as it is called, is made of the fineſt of theſe threads, covered with tin. The women do this buſineſs, and the way they take is to melt a piece of tin, and placing at the edge of it a horn with a hole through it, they draw theſe ſinewy threads, covered with the tin, through the hole, which prevents their coming out too thick covered. This drawing is performed with their teeth; and there is a ſmall piece of bone placed at the top of the hole, where the wire is made flat, ſo that we always find it rounded on all ſides but one, where it is flat.

This wire they uſe in embroidering their cloaths as we do gold and ſilver; they often ſell it to ſtrangers, under the notion of its having certain magical virtues.

WITCHCRAFT.

WICTHCRAFT, a kind of ſorcery, eſpecially in women, in which it is ridiculouſly ſuppoſed that an old woman, by entering into a contract with the devil, is enabled, in many inſtances, to change the courſe of nature; to raiſe winds; perform actions that require more than human ſtrength; and to afflict thoſe who offend them with the ſharpeſt pains, *&c.*

In the times of ignorance and ſuperſtition, many ſevere laws were made againſt witches, by which great numbers of innocent perſons, diſtreſſed with poverty and age, were brought to a violent death; but theſe are now happily repealed.

WITENA-MOT, or WITENA-GEMOT, among our ſaxon anceſtors, was a term which literally ſignified the aſſembly of the wiſe men, and was applied to the great council of the nation, of latter days called the parliament.

W O O L.

WOOL, the covering of ſheep, Each fleece conſiſts of wool of ſeveral qualities and degrees of fineneſs, which the dealers therein take care to ſeparate.

The Engliſh and French uſually ſeparate each fleece into three principal ſorts, viz. 1. Mother-wool, which is that of the back and neck. 2. The wool of the tails and legs. 3. That of the breaſt and under the belly. The wool moſt eſteemed is the Engliſh, chiefly that about Leominſter, Cotſwold, and the Iſle of Wight; the Spaniſh, principally that about Segovia; and the French, about Berry.

The fineneſs and plenty of our wool is owing in a great meaſure to the ſhort ſweet graſs in many of our paſtures and downs; though the advantage of our ſheeps feeding on this graſs all the year, without being obliged to be ſhut up under cover during the winter, or to ſecure them from wolves at other times, contributes not a little to it.

Antiently, the principal commerce of the nation conſiſted in wool unmanufactured; which foreigners, eſpecially the French, Dutch, and Flemiſh, bought of us, inſomuch, that the cuſtoms paid on wool exported in the reign of Edward III. amounted, at 50s. a pack, to 250,000 l. per annum. An immenſe ſum in thoſe days! But as wool is now accounted a ſtaple commodity, the employment of an infinite number of people at home, and our moſt beneficial trade abroad, depending upon it, very ſevere laws have been made to prevent its being exported, and perſons that export wool beyond the ſeas, are liable to a forfeiture of the ſhips or veſſels in which it is found, with treble the value, and the perſons aiding and aſſiſting in it ſhall ſuffer three years impriſonment. It is alſo enacted, that no ſheep ſhall be carried on board any ſhip with intent to be exported, upon forfeiture of 20s. for every ſheep; that the owners knowing thereof, are to forfeit their intereſt therein; that if they be aliens, or natural born ſubjects not inhabiting this kingdom, ſuch ſhips ſhall be wholly forfeited; that the maſters and mariners knowing thereof, and aſſiſting therein, are to forfeit all their goods and chattels, and to ſuffer three months impriſonment; and that the exporter, beſides other penalties, ſhall be rendered incapable of ſuing for any debt, *&c.* As to the importation of wool, Iriſh wool, combed or uncombed, Spaniſh and Poliſh wool may be imported duty free.

WOOL is alſo uſed for the ſoft hair growing on ſeveral wild beaſts, the ſkins of which are diſtinguiſhed by the name of furrs.

Theſe kinds of wool, on being imported, pay the following duties: bever-wool, cut and combed, 14s. $\frac{1}{4}$d. the pound: the whole of which is drawn back on exportation: but if this wool be combed in Ruſſia, and imported from thence in Britiſh ſhips, it is free. Coney-wool, the pound, $1\frac{43\frac{1}{2}}{100}$d. draw back $1\frac{29\frac{1}{2}}{100}$d. Eſtridge wool, imported in Britiſh-built ſhips, free; but if imported in thoſe that are foreign built, it pays 6s. $8\frac{4\frac{1}{2}}{100}$d. the 112 pounds: draw back, 6s. $7\frac{4\frac{1}{2}}{100}$d. Stanes-wool, the pound $\frac{71\frac{1}{16}}{100}$d. draw back $\frac{64\frac{1}{16}}{100}$d.

WOOLEN MANUFACTORY includes the ſeveral ſorts of commodities into which wool is wrought, as broad cloth, long and ſhort kerſeys, bays, ſerges, flannel, perpetuanas, ſays, ſtuffs, frize, penniſtones, ſtockings, caps, rugs, *&c.*

W O R D.

WORD, in language, an articulate ſound deſigned to repreſent ſome Idea.

The Port-royaliſts define words to be diſtinct articulate ſounds, agreed on by mankind to convey their thoughts and ſentiments by.

Word, in writing, is defined to be an aſſemblage of ſeveral letters forming one or more ſyllables, and expreſſing the name, quality, or manner of a thing.

Etymology and ſyntax being the two parts of grammar converſant about words, the firſt of theſe explains the nature and propriety of words, and the other treats of the right compoſition of words in diſcourſe.

The moſt remarkable thing in the pronouncing of words, is the accent, or the elevation of the voice, on ſome particular ſyllable of the word, which elevation is neceſſarily followed by a depreſſion of the voice.

Grammarians

Grammarians generally divide words into eight claſſes, called parts of ſpeech.

Words are again divided into primatives and derivatives, ſimple and compound, ſynonimous and equivocal.

With regard to their ſyllables, words are farther divided into monoſyllables and polyſyllables.

The grammatical figures of words which occaſion changes in the form, &c. thereof are proſtheſis, aphæreſis, ſyncope, epentheſis, apocope, paragoge, craſis, diæreſis, metatheſis, and anitheſis.

The uſe of words, we have obſerved, is to ſerve as ſenſible ſigns of our ideas; and the ideas they ſtand for in the mind of the perſon that ſpeaks, are their proper ſignifications.

Simple and primitive words have no natural connection with the things they ſignify, whence there is no rationale to be given of them; it is by mere arbitrary inſtitution and agreement of men, that they come to ſignify any thing. Certain words have no natural propriety or aptitude to expreſs certain thoughts more than others; were that the caſe there could have been but one language. But in derivative and compound words the caſe is ſomewhat different. In the forming of theſe, we ſee regard is had to agreement, relation, and analogy; thus moſt words that have the ſame ending, have one common and general way of denoting or ſignifying things; and thoſe compounded with the ſame prepoſitions, have a ſimilar manner of expreſſing and ſignifying ſimilar ideas, in all the learned languages where they occur.

For the perfection of language, it is not enough, Mr. Locke obſerves, that ſounds can be made ſigns of ideas, unleſs theſe can be made uſe of ſo as to comprehend ſeveral particular things; for the multiplication of words would have perplexed their uſe, had every particular thing needed a diſtinct name to be ſignified by. To remedy this inconvenience, language had a further improvement in the uſe of general terms, whereby one word was made to mark a multitude of particular exiſtences; which advantageous uſe of ſounds was obtained by the difference of the ideas they were made ſigns of, thoſe names becoming general which are made to ſtand for general ideas, and thoſe remaining particular, where the ideas they are uſed for are particular.

It is obſervable, that the words which ſtand for actions and notions, quite removed from ſenſe, are borrowed from ſenſible ideas; as to imagine, apprehend, comprehend, underſtand, adhere, conceive, inſtil, diſguſt, diſturbance, tranquility, &c. which are all taken from the operations of things ſenſible, and applied to modes of thinking. Spirit, in its original ſignification, is no more than breath; angel, a meſſenger. By which we may gueſs what kind of notions they were, and whence derived, which filled the minds of the firſt beginners of languages; and how nature, even in the naming of things unawares, ſuggeſted to men the originals of all their knowledge: whilſt to give names that might make known to others any operations they felt in themſelves, or any other ideas that came not under their ſenſes, they were forced to borrow words from the ordinary and known ideas of ſenſation.

The ends of language in our diſcourſe with others, are chiefly three; firſt, to make our thoughts or ideas known one to another. This we fail in, 1. when we uſe names without clear and diſtinct ideas in our mind. 2. When we apply received names to ideas, to which the common uſe of that language doth not apply them. 3. When we apply them unſteadily, making them ſtand now for one, and anon for another idea. Secondly, to make known our thoughts with as much eaſe and quickneſs as poſſible. This men fail in, when they have complex ideas, without having diſtinct names for them, which may happen either through the defect of a language which has none, or the fault of the man who has not yet learned them. Thirdly, to convey the knowledge of things. This cannot be done, but when our ideas agree to the reality of things. He that has names without ideas, wants meaning in his words, and ſpeaks only empty ſounds. He that has complex ideas, without names for them, wants diſpatch in his expreſſion. He that uſes his words looſely and unſteadily, will either not be minded or not underſtood. He that applies names to ideas, different from the common uſe, wants propriety in his language, and ſpeaks gibberiſh; and he that has ideas of ſubſtances diſagreeing with the real exiſtence of things, ſo far, wants the materials of true knowledge.

W O R L D.

WORLD, *mundus*, the aſſemblage of parts which compoſe the univerſe.

The duration of the world is a thing which has been greatly diſputed. Plato, after Ocellus Lucanus, held it to be eternal, and to have flowed from God as rays flow from the ſun. Ariſtotle was much of the ſame mind; he aſſerts, that the world was not generated ſo as to begin to be a world, which before was none: he lays down a pre-exiſting and eternal matter as a principle, and thence argues the world eternal. His arguments amount to this, that it is impoſſible an eternal agent, having an eternal paſſive ſubject, ſhould continue long without action. His opinion was generally followed, as ſeeming to be the fitteſt to end the diſpute among ſo many ſects about the firſt cauſe.

Epicurus, however, though he makes matter eternal, yet ſhews the world to be but a new thing formed out of a fortuitous concourſe of atoms.

Some of the modern philoſopers refute the imaginary eternity of the world by this argument, that if it be *ab æterno*, there muſt have been a generation of individuals in a continual ſucceſſion from all eternity, ſince no cauſe can be aſſigned why they ſhould not be generated, *viz.* one from another. Therefore to conſider the origin of things, and the ſeries of cauſes, we muſt go back in infinitum, *i. e.* there muſt have been an infinite number of men and other individuals already generated, which ſubverts the very notion of number. And if the cauſe which now generates has been produced by an infinite ſeries of cauſes, how ſhall an infinite ſeries be? Dr. Halley ſuggeſts a new method of finding the age of the world, from the degree of the ſaltneſs of the ocean.

W O R M S.

WORMS, in the linnæan ſyſtem of nature, a claſs of inſects of the order of the apteria, and of the claſs of the anarthra.

The diſtinguiſhing character of this claſs is, that they have the muſcles of their body affixed to a ſolid baſis. The ſeveral ſpecies of worms are very numerous; as the chætia, or the hair-worm, called alſo the guinea-worm; the aſcaris, the lumbricus, or earth-worm, and ſea-worm; the tænia, or tape-worm; the ſicyania, or gourd-worm; the julus or gally-worm, *&c.*

WORMS, in huſbandry, are very prejudicial to corn-fields, eating up the roots of the young corn, and deſtroying great quantities of the crop. Sea-ſalt is the beſt of all things for deſtroying them. Sea-water is proper to ſprinkle on the land, where it can be had? where the ſalt-ſprings are, their water will do; and where neither are at hand, a little common or bay-ſalt does as well. Soot will deſtroy them in ſome lands, but is not to be depended upon, for it does not always ſucceed. Some farmers ſtrew on their lands a mixture of chalk and lime; and others truſt wholly to their winter fallowing to do it, if this is done in a wet ſeaſon, when they come up to the ſurface of the ground, and ſome nails with ſharp heads be driven into the bottom of the plough. If they are troubleſome in gardens, the refuſe brine of ſalted meat will ſerve the purpoſe, or ſome walnut leaves ſteeped in a ciſtern of water for a fortnight or three weeks, will give it ſuch a bitterneſs, that it will be a certain poiſon to them. A decoction of wood-aſhes, ſprinkled on the ground, will anſwer the ſame purpoſe; and any particular plant may be ſecured both from worms and ſnails by ſtrewing a mixture of lime and aſhes about its roots. It is a general caution among the farmers to ſow their corn as ſhallow as they can, where the field is very ſubject to worms.

WORMS, in medicine, a diſeaſe ariſing from ſome of theſe reptiles being ingendered in the body, particularly in the ſtomach and inteſtines.

When children begin to uſe crude aliments, ſummer fruits, fleſh, cheeſe, and other things of the like kind, they are frequently troubled with the worms, occaſioned by the eggs of inſects, which either float in the air, or live on the earth, and which being caſually ſwallowed, are not digeſtible by their tender ſtomachs. For theſe, the inteſtinal or gaſtric pituit, afford a neſt in which they

they reſide, are nouriſhed, breed, and increaſe in bulk. Hence they are not ſo common in adults, except in the dull and ſluggiſh, and in the leucophlegmatic.

There are three ſpecies of worms, moſt frequent in the human body; the lumbrici, the aſcarides, and the tænia. The lumbrici are found in the ilion, and are thus called, becauſe they are generally broad and long, and roll themſelves up in a ſtrange manner. The aſcarides have their ſeat chiefly in the groſs inteſtines, and are more plentiful in the rectum; they are round and ſmall, and are thrown out in large quantities. The broad worm called tænia is like a ſwathe, commonly two ells long, but ſometimes much longer, and divided through the whole length with croſs joints or knots. This is ſaid to be always ſingle; and lies variouſly convoluted, being ſometimes as long as all the guts, and ſometimes vaſtly exceeding even that length. Heiſter obſerves, that there are other kinds of inſects, or worms, generated in an human body, which phyſicians have not placed in any particular claſs, but have looked upon them as uncommon productions.

Worms by their irritation, create nauſeas, vomitings, looſeneſſes, faintings; a ſlender, deficient, intermitting pulſe; itching of the noſe, and epileptic fits. By the conſumption of the chyle, they produce hunger, paleneſs, weakneſs, and coſtiveneſs; whence ariſes a tumour of the abdomen, eructations, and rumbling of the inteſtines.

A child may be known to have the worms from his age, cold temperament, paleneſs of the countenance, livid eyelids, hollow eyes, itching of the noſe, voracity, ſtartings, and grinding the teeth in ſleep; and more eſpecially by a ſingular ſtinking breath; but when they are voided by the mouth, or anus, there remains no manner of doubt.

The cure is to be performed chiefly by deſtroying their neſts, which is to be attempted by alkalious ſalts, gums which purge phlegm, mercurials, antimonials, and bitter aromatics.

Y.

Y, or y, the twenty-third letter of our alphabet: its ſound is formed by expreſſing the breath with a ſudden expanſion of the lips from that configuration by which we expreſs the vowel *u*. It is one of the ambigenial letters, being a conſonant in the beginning of words, and placed before all vowels, as in *yard*, *yield*, *young*, *&c.* but before no conſonant. At the end of words it is a vowel, and is ſubſtituted for the ſound of *i*, as in *try*, *deſcry*, *&c.* In the middle of words it is not uſed ſo frequently as *i* is, unleſs in words derived from the Greek, as in *chyle*, *empyreal*, *&c.* though it is admitted into the middle of ſome pure Engliſh words, as in *dying*, *flying*, *&c.* The Romans had no capital of this letter, but uſed the ſmall one in the middle and laſt ſyllables of words, as in *coryambus*, *onyx*, *martyr*. Y is alſo a numeral, ſignifying 150, or according to Baronius, 159; and with a daſh a-top as $\bar{Y}$, it ſignified 150,000.

YARN.

YARN, wool or flax, ſpun into thread, of which they weave cloth, *&c.*

Yarn is ordered after the following manner: after it has been ſpun upon ſpindles, ſpools, or the like, they reel it upon reels, which are hardly two feet in length, and have but two contrary croſs-bars, being the beſt, and the leaſt liable to ravelling. In reeling of fine yarn, the better to keep it from ravelling, you muſt, as it is reeled, with a tye-band of big twiſt, divide the ſlipping or ſkain into ſeveral leys, allowing to every ley eighty threads, and twenty leys to every ſlipping, if the yarn is very fine; otherwiſe leſs of both kinds. The yarn being ſpun, reeled, and in the ſlippings, the next thing is to ſcour it. In order to fetch out the ſpots, it ſhould be laid in lukewarm water for three or four days, each day ſhifting it once, wringing it out, and laying it in another water of the ſame nature: then carry it to a well or brook, and rinſe it till nothing comes from it but pure clean water: that done, take a bucking tub, and cover the bottom thereof with very fine aſhen aſhes; and then having opened and ſpread the ſlip-

pings, lay them on thoſe aſhes, and put more aſhes above, and lay in more ſlippings, covering them with aſhes as before; and thus lay one upon another, till all the yarn be put in: afterwards cover the uppermoſt yarn with a bucking cloth, and, in proportion to the bigneſs of the tub, lay therein a peck or two more of aſhes: this done, pour upon the uppermoſt cloth a great deal of warm water, till the tub can receive no more, and let it ſtand ſo all night. Next morning you are to ſet a kettle of clean water on the fire; and when it is warm, pull out the ſpiggot of the bucking tub, to let the water run out of it, into another clean veſſel; as the bucking tub waſtes, fill it up again with the warm water on the fire: and as the water on the fire waſtes, ſo likewiſe fill that up with the lye that comes from the bucking-tub; ever obſerving to make the lye hotter and hotter, till it boils: then you muſt, as before, ply it with the boiling lye at leaſt four hours together, which is called the driving of a buck of yarn.

All this being done, for the whitning of it, you muſt take off the bucking cloth; then putting the yarn with the lye-aſhes into large tubs, with your hands labour the yarn, aſhes, and lye pretty well together; afterwards carry it to a well, or river, and rinſe it clean; then hang it upon poles in the air all day, and in the evening take the ſlippings down, and lay them in water all night; the next day hang them up again, and throw water upon them as they dry, obſerving to turn that ſide outmoſt which whitens ſloweſt. After having done this for a week together, put all the yarn again into a bucking-tub, without aſhes, covering it as before with a bucking-cloth; lay thereon good ſtore of freſh aſhes, and drive that buck, as before, with very ſtrong boiling lye, for half a day, or more; then take it out, and rinſe it, hanging it up, as before, in the day-time, to dry, and laying it in water at night, another week: laſtly, waſh it over in fair water, and ſo dry it up. Your yarn being thus ſcoured and whitened, wind it up into round balls of a moderate ſize. See Reel.

Cable yarn pays, on importation, for the hundred weight 7 s. $3\frac{5}{100}$ d. there is no drawback on exportation. Camel or mohair-yarn pays on importation for the hundred weight $5\frac{77\frac{1}{2}}{100}$ d. and draws back $5\frac{6\frac{1}{2}}{100}$ d. Cotton-yarn, not of the Eaſt-indies, on importation, pays per pound $2\frac{87\frac{1}{2}}{100}$ d. and on exportation draws back $2\frac{58\frac{3}{4}}{100}$ d. Cotton-yarn of the Eaſt-indies, on importation, pays per pound $4\frac{56}{100}$ d. and on exportation draws back $4\frac{27\frac{1}{2}}{100}$ d. Grogram-yarn, on importation, pays per pound $6\frac{9\frac{1}{2}}{100}$ d. and on exportation draws back $6\frac{7\frac{1}{2}}{100}$ d. Iriſh yarn, in packs containing four hundred weight, at ſix ſcore pound to the hundred, if by certificate, is free from any duty on importation. Sail-yarn, on importation, pays per pound $1\frac{47\frac{5}{8}}{100}$ d. and on exportation draws back $1\frac{29\frac{3}{8}}{100}$ d. For every pound weight of French, Dutch, Muſcovia or ſpruce, and all other raw linnen-yarn, there is a duty of 1 d. on importation; and no draw-back on exportation. Wick-yarn on importation, pays, the dozen pound, 2 s. $1\frac{85\frac{1}{2}}{100}$ d. and on exportation draws back 1 s. $11\frac{28\frac{3}{4}}{100}$ d. Woollen or bay-yarn, on importation, pays the hundred 12 s. 10 d. and on exportation draws back 11 s. 3 d. Worſted-yarn, being two or more threads twiſted or thrown, on importation, pays the pound $2\frac{87\frac{1}{2}}{100}$ d. and on exportation draws back $2\frac{58\frac{3}{4}}{100}$ d.

YAWS.

Yaws, in the ſea-language. A ſhip is ſaid to make yaws, when ſhe does not ſteer ſteady, but goes in and out when there is a ſtiff gale.

Yaws, a diſtemper endemial to Guinea and the hotter climates in Africa. It makes its firſt appearance in little ſpots on the cuticle, not bigger than a pin's point, which increaſes daily, and become protuberant, like pimples. Soon after, the cuticle frets off, and then, inſtead of pus or ichor, there appears white ſloughs or ſordes, under which is a ſmall red fungus. Theſe increaſe gradually, ſome

ſome to the ſize of a ſmall wood ſtrawberry, others to that of a raſpberry, others again exceed the largeſt mulberry, which in ſhape they very much reſemble. In the mean time the black hair growing in the yaws turns to a tranſparent white. It is not eaſy to determine the exact time which the yaws take in going through their different ſtages. Luſty well fed negroes have had ſeveral yaws as big as a mulberry in a month's time, whereas the low in fleſh, with a ſcanty allowance, have paſſed three months without their growing to the ſize of a ſtrawberry. They appear in all parts of the body, but are moſt plentiful, and of the largeſt ſize, about the groin, privy parts, anus, armpits, and face: they are largeſt when feweſt in number, and *vice verſa*. They are not painful, unleſs handled roughly, nor cauſe a loſs of appetite. They continue long without any ſenſible alteration; and ſome are of opinion, that as ſoon as the funguſes become dry, the infection is exhauſted.

The yaws are not dangerous, if the cure is ſkillfully managed at a proper time. But if the patient has been once ſalivated, or has taken any quantity of mercury, and his ſkin once cleared thereby, the cure will be very difficult, if not impracticable. The following form of medicine is recommended as a cure: take of flowers of ſulphur, one ſcruple; of camphor diſſolved in ſpirits of wine, five grains; of theriaca andromachi, one drachm; and as much of ſyrup of ſaffron as will make a bolus. Let the bolus be taken at going to reſt, which muſt be repeated for a fortnight or three weeks, till the yaws come to the height. Then throw the patient into a gentle ſalivation, with calomel given in ſmall doſes, without farther preparation. After ſalivation, ſweat the patient twice or thrice, on a frame or chair, with ſpirit of wine, and give the following electuary, *viz.* of æthiops mineral, one once and a half, of gum guaiacum, half an ounce; theriaca andromachi, and conſerve of red roſes, of each one ounce; oil of ſaſſafras, twenty drops; and as much of ſyrup of ſaffron as is requiſite for an electuary. Of this let two drachms be taken in the morning and at night. He may likewiſe drink the decoction of guaiacum and ſaſſafras, fermented with molaſſes, for his conſtant drink, while the electuary is taking, and a week or a fortnight after the electuary is ſpent. Sometimes there remains one large yaw, high and knobed, red and moiſt; this is called the maſter-yaw. This muſt be conſumed an eighth or a tenth part of an inch below the ſkin, with corroſive red mercury, and burnt alum, of each an equal quantity, and digeſted with one ounce of yellow baſilicon, and one drachm of red corroſive mercury, and cicatrized with lint preſſed out of ſpirit of wine, and with the vitriol-ſtone.

Z.

Z, or z, the twenty-fourth and laſt letter, and the nineteenth conſonant of our alphabet; the ſound of which is formed by a motion of the tongue from the palate downwards and upwards to it again, with a ſhutting and opening of the teeth at the ſame time. This letter has been reputed a double conſonant, having the ſound *d s*; but ſome think with very little reaſon; and, as if we thought otherwiſe, we often double it, as in *puzzle*, *muzzle*, &c. Among the antients, Z was a numeral letter, ſignifying two thouſand, and with a daſh added a-top, $\overline{Z}$ ſignified two thouſand times two thouſand, or four millions.

In abreviations this letter formerly ſtood as a mark for ſeveral ſorts of weights; ſometimes it ſignified an ounce and a half, and very frequently it ſtood for half an ounce; ſometimes for the eighth part of an ounce, or a drachm troy weight; and it has in earlieſt times been uſed to expreſs the third part of an ounce, or eight ſcruples. ZZ were uſed by ſome of the antient phyſicians to expreſs myrrh, and at preſent they are often uſed to ſignify zinziber, or ginger.

ZOOLOGY.

ZOOLOGY, ζωολογια, the ſcience of animals. Artedi obſerves, that this makes one of the three kingdoms, as they are called, of natural hiſtory; the vegetable and the mineral being the two others: in theſe, however, there is this difference made by writers, that while vegitables and minerals are treated of together, as all of a piece

piece in each, the ſubjects of zoology are divided; and it is made to compoſe, as it were, ſeveral kingdoms. Whoever is to write on plants and minerals, calls his work a treatiſe of botany, or mineralogy; and we have no words to expreſs any ſubdiviſion of them into kingdoms: but, in zoology, we treat as different ſubjects, the different parts of it; and the hiſtory of birds is ſeperated by ſome from the reſt under the name of ornithology; that of quadrupeds under the name of tetrapodology; and we have for the reſt, the words entomology, amphibiology, and the like, expreſſing theſe things which are properly but the parts of zoology, as ſo many diſtinct and ſeperate ſtudies.

The ſame author obſerves, that this may eaſily be amended, by our conſidering the animal world as we do the vegetable and mineral, and dividing it, as we do the others, into its proper families; it will then be found that theſe are no better diſtinctions than thoſe of the families of theſe things, and that the authors may as well ſet up ſeperate ſtudies under the names of bulbology, umbelliferology, and the like, as thoſe.

A natural diviſion of the ſubjects of zoology, on this principle, will afford ſix ſeveral families of its ſubjects. 1. The hairy quadrupeds. 2. The birds. 3. The amphibious animals, ſuch as ſerpents, lizards, frogs, and tortoiſes. 4. The fiſhes. 5. The inſects.—And ſixthly, thoſe loweſt order of animated beings the zoophytes.

ZOOTOMY.

ZOOTOMY, is the art or act of diſſecting living creatures.

Zootomy amounts to the ſame with *comparitive anatomy*, which is that branch of anatomy which conſiders the ſame parts of different animals, with relation to the particular ſtructure and formation, which is beſt ſuited to the manner of living, and to the neceſſity of every creature.

Thus in the *comparative anatomy* of ſtomachs, for inſtance, it is remarkable that thoſe creatures which have the opportunities of frequent feeding, have their ſtomach very ſmall, in compariſon to ſome creatures of prey, which probably may be under a neceſſity of faſting a long time; and therefore have ſtomachs large enough to hold food ſufficient for ſuch a time.

Ruminating animals have four ſtomachs; yet it is obſerved that ſome of theſe, which have four in *Europe*, have only two in *Africa*, probably by reaſon the herbs in *Africa* are more nouriſhing.

Ruminants, Mr. *Ray* obſerves, are all quadrupedal, hairy, and viviparous; ſome with hollow and perpetual horns, others with decidious ones.

The horned ruminants have all four ſtomachs, appropriated to the office, *viz.* 1. The *rumen*, *venter magnus*, or what is called in *Engliſh* the *paunch*, or inward, which receives the meat ſlightly chewed, retains it awhile, and then delivers it back again into the mouth, which is called in *Engliſh* the *cud*, to be re-chewed.—2. The *reticulum*, called in *Engliſh* the *honey-comb*, from its internal coat being divided into cells, like honey-combs.—3. What is commonly called *anaſus*, and Mr. *Ray*, *echinus*; this being difficult to clear, is commonly thrown away, and called the manifold.—4. That which *Gaza* calls *abamaſus*, the *Engliſh* call the *maw*.

The rumen or paunch is much the largeſt of all the ſtomachs; as being to contain both the drink, and the whole crude maſs of aliment, which there lie and macerate together; to be thence remitted to the mouth, to be rechewed and comminuted, in order to their further digeſtion in the other ventricles.

In the *rumen*, or firſt ventricle of camels, are found divers ſacculi, which contain a conſiderable quantity of water; an admirable contrivance for the neceſſities of that animal, which living in dry countries, and feeding on dry hard food, would be in danger of periſhing, but for thoſe reſervoirs of water.

Burnet, in his *Theſaur. Med.* gives ſeveral inſtances of men that ruminated, from *ſalmuth*, *rhodrics*, &c.—Dr. *Slare*, in the *Philoſophical Tranſactions*, gives us a freſher inſtance, in an *Engliſhman* living at *Briſtol*. His account as it is curious, and may let us ſee a little how it fares with ruminating animals, we ſhall here add.

'He begins to chew his meat over again within 'a quarter of an hour after meals, if he drinks 'with it; if not, ſomewhat later. His chewing 'after a full meal laſts about an hour and a half; 'and if he goes to bed preſently after meals, he 'cannot ſleep till the uſual time of chewing be 'over. The victuals upon the return, taſte ſome'what more pleaſantly than at firſt, bread, meat,

'cheese, and drink, return much of such colours 'as they would be of, were they mixed together in 'a mortar. Liquids, as spoon-meat, return to 'his mouth all one as dry and solid food. The victuals seem to him to lie heavy till they have passed 'the second chewing; after that they pass clean 'away. If he eats variety of things, that which passes 'down first comes up again first. If the ruminating 'faculty chance to leave him, it signifies sickness; 'and it is never well with him till it return. He 'is about 20 years of age, and was always thus 'since he can remember. His father does the like 'sometimes, but in small quantities.'

Birds that live ordinarily on seeds with a tough rind, have a kind of stomach called the *crop* or *gizzard*, consisting of four large muscles without-side, and a hard callous membrane within.---Such as live on flesh, as eagles, vultures, &c. have only one.

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MUSEUM

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